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ENGINEERING EVALUATION/COST ANALYSIS FOR THE RIVERDALE CHEMICAL COMPANY SITE CHICAGO HEIGHTS COOK COUNTY, ILLINOIS

TDD NO. S05-9908-011A
PAN: 9G1101REXX

March 2000

Prepared for:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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EE/CA
Engineering Evaluation/Cost Analysis

Riverdale
Riverdale Chemical Company

E & E
Ecology and Environment, Inc.

START
Superfund Technical Assessment and Response Team

U.S. EPA
United States Environmental Protection Agency

TDD
Technical Direction Document

AST
aboveground storage tank

This Engineering Evaluation/Cost Analysis (EE/CA) for the Riverdale Chemical Company (Riverdale) was prepared by the Ecology and Environment, Inc., (E & E) Superfund Technical Assessment and Response Team (START) under United States Environmental Protection Agency (U.S. EPA) Contract No. 68-W6-0011 and Technical Direction Document (TDD) No. S05-9908-011A. The purpose of the EE/CA is to identify removal action goals and evaluate removal action alternatives for on-site soil contamination.

Riverdale, an active producer of agricultural and turf chemicals, is located at 220 East 17th Street in Chicago Heights, Illinois. Riverdale, which purchased the 10-acre site in 1956, previously formulated various fungicide, herbicide, and insecticide products at the facility. Previous owners used the site for carriage building, brewing, and warehouse storage. Structures on the site include three main buildings, a smaller ancillary building, and an aboveground storage tank (AST) area (see Figure 2-2). Building No. 1 is located at the west side of the site and is used as a Finished Goods Warehouse. Building No. 2, Manufacturing Building, contains the administrative offices, laboratory, and some manufacturing and packaging operations. Building No. 3 is used for raw material storage and manufacturing. Packaging supplies are contained in Building No. 4 (RMT 1999). The ASTs hold liquid chemicals used in the process.

Chicago Heights is located along the southern border of the Chicago, Illinois/Gary, Indiana, metropolitan area. The Riverdale site is located in the southeastern portion of Chicago Heights. While zoned for industrial use, the site is located in a mixture of residential, commercial, and industrial neighborhoods. Within a 3-mile radius of the site, approximately 10,000 people are served by private wells. In addition, nine public water supply wells servicing South Chicago Heights and East Chicago Heights, and 12 industrial wells providing production water for local industries have been identified.

FIT
Field Investigation Team

VOCs
volatile organic compounds

PAHs
polynuclear aromatic hydrocarbons

2,3,7,8-TCDD
2,3,7,8-tetrachlorodibenzo-p-dioxin

µg/kg
micrograms per kilogram

RI/FS
Remedial Investigation/Feasibility Study

AOC
Administrative Order of Consent

IRM
Interim Response Measure

BHC
benzene hexachloride

In April 1984, U.S. EPA tasked E & E's Field Investigation Team (FIT) to conduct a site investigation at the Riverdale site. The investigation was conducted as part of the National Dioxin Test Strategy Program. Pesticides, volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), phenolic compounds, and 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD) were detected in the 15 samples collected by FIT. The compound 2,3,7,8-TCDD was detected at a maximum concentration of 394 micrograms per kilogram (µg/kg). Based on the findings of the FIT investigation and the proximity of the site to residential areas, a more complete delineation of the extent of contamination was deemed necessary, and U.S. EPA entered into negotiations with Riverdale to perform a Remedial Investigation/Feasibility Study (RI/FS) at the site.

As a result of the FIT investigation findings and as part of the Administrative Order by Consent (AOC) between Riverdale and U.S. EPA, an interim response measure (IRM) was initiated. The IRM consisted of placing a layer of crushed limestone over approximately 20,000 square feet of the site. In addition, a geofabric was placed over soils determined to contain the highest levels of contamination. Riverdale has continued to maintain this cover to date by trucking in limestone. The current thickness of the limestone cover has been estimated by Riverdale personnel to be approximately 1 foot.

Also as a result of the FIT investigation and as part of the AOC, an RI was conducted at the Riverdale site. The RI focused on delineating surface soil and subsurface soil contamination within the manufacturing areas. RI fieldwork was conducted in two phases, with the initial phase starting in October 1985 and the second phase completed in November 1986.

Data from the surface soil portion of the RI detected widespread pesticide and dioxin contamination. The maximum concentrations of pesticides detected in the surface soil ranged from 130 µg/kg for gamma-benzene hexachloride (BHC; lindane) to 1 million µg/kg for chlorodane. The average detected concentration for dioxin in the surface soil was 17.5 µg/kg, with a maximum detected concentration of 197 µg/kg.

The subsurface soil investigative phase of the RI focused on the southern portion of the active site. Pesticide contamination was found to be widespread in samples collected from the interval of 0 to 3 feet below ground surface (BGS). The maximum detected concentrations of pesticides ranged from 160 µg/kg for heptachlor epoxide to 200,000 µg/kg for dieldrin. Dioxin contamination in the subsurface soil was limited. However, dioxin was detected at 0.8 µg/kg in a single sample collected from the 6.5- to 8-foot BGS interval.

BGS
below ground surface

TAT
Technical Assistance Team

Illinois EPA
Illinois Environmental Protection Agency

ATSDR
Agency for Toxic Substances and Disease Registry

BNA
Base/neutral and acid extractable organic compound

PCB
polychlorinated biphenyl

On July 2, 1992, E & E's Technical Assistance Team (TAT) was tasked by U.S. EPA to provide emergency technical support to a fire response at the Riverdale site. The fire at the site began after a 10,000-square-foot warehouse was struck by lightning.

The warehouse contained various fungicide, herbicide, and insecticide products, including the active ingredients 2,4-D, Dicamba, 2,4-DP, MCPA, MCPP, and oxidizers. These products were stored in the brick construction warehouse on a concrete slab floor. It was estimated that the fire consumed 85% of the contents of the warehouse. After the fire was extinguished, the fire residue was contained within the shell of the warehouse, and permitted for proper disposal. Water used to fight the fire was diverted, through emergency excavation procedures, to a low area north of the warehouse and to a drainage pond southeast of the warehouse. The collected water was discharged to the sewer system for treatment with the approval of the U.S. EPA, the Illinois Environmental Protection Agency (Illinois EPA), and the Thorn Creek Basin Sanitary District (RMT 1999).

In 1996, E & E's TAT was tasked by U.S. EPA to collect off-site residential samples as part of an Agency for Toxic Substances and Disease Registry (ATSDR) study. TAT collected three surface soil samples and one duplicate sample from residences located immediately north of the Riverdale site. The samples were analyzed for base/neutral and acid extractable organic compounds (BNAs), chlorinated organic pesticides, and polychlorinated biphenyls (PCBs), but not dioxins. PAHs and pesticides were detected in the soil samples; however, the study concluded that the concentrations detected in the residential yards do not pose a public health hazard.

Streamlined Risk Evaluation

Ecological Evaluation

An ecological survey and evaluation of the site was conducted to the ecosystems on and near the site and determine whether valuable ecological resources might be affected by site contaminants. The terrestrial habitat is the predominant habitat type at the site and consists mainly of barren land and open fields. A small area of wetland habitat also was identified in the southeast corner and along the southern border of the site. Several federal or state species of potential concern reportedly exist in the general vicinity of the site, however consideration of their habitat needs and preferences suggests that they are not likely to be found in the immediate vicinity of the site.

Contaminants were found in site soils that could adversely affect terrestrial species. However, because the terrestrial habitat at the site was of limited size and quality, potential exposure pathways for terrestrial species were judged to be essentially non existent and were not quantitatively assessed. The wetlands portions of the site have not been sampled so it is not known whether contamination exists in these areas. However, potential surface runoff pathways were documented leading from areas of the site where substantial contamination was found in soil to the wetland areas. Although limited in size, the wetlands area was judged to be a potentially valuable resource for local wildlife and migratory waterfowl. Sampling of the wetlands is recommended to characterize any contamination that may be present and to permit an adequate assessment of any environmental impacts that may result.

Human Health Evaluation

The site is currently an active industrial facility and is expected to continue to be used in that way. Therefore site workers and construction and utility workers who engage in activities that disturb the soil are the individuals most likely to be exposed to site contaminants. There is a sparsely populated residential area adjacent to the north side of the site, however that side of the site is fenced and guarded making significant exposure of site visitors or trespassers unlikely.

HIs
hazard index

Potential exposure of general site workers and construction/utility workers to contaminants in site soils through dermal contact with, and incidental ingestion of soil resulting from hand-to-mouth contact was evaluated. The estimated cancer risks for general site workers and construction/utility workers were 2.2×10^{-2} and 4.6×10^{-4} respectively; the estimated noncancer hazard indices (HIs) were 39.6 and 51.4, respectively. These estimates all exceed the maximum cancer risk (10^{-4}) and noncancer HI (1) generally considered acceptable by U.S. EPA.

RAOs
Removal Action Objectives

NCP
National Oil and Hazardous Substances Pollution Contingency Plan

ARARs
Applicable or Relevant and Appropriate Requirements

TBCs
to-be-considered criteria

COPCs
chemicals of potential concern

Removal Action Objectives

Removal action objectives (RAOs) were developed to provide a basis for the identification and evaluation of alternatives for the removal action. The RAOs were developed in accordance with the *National Oil and Hazardous Substances Pollution Continency Plan* (the NCP; U.S. EPA 1992d) and *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (U.S. EPA 1993a). In developing the RAOs, federal, state, and local applicable or relevant and appropriate requirements (ARARs) and other to-be- considered criteria (TBCs) were evaluated.

Based on the identified ARARs and TBCs, and the need to reduce the potential threat to human health and the environment, the following general RAOs were developed for the Riverdale site:

- Reduce the potential for industrial worker and construction worker exposure to soil contaminants either by reducing the contaminant concentration present, or by reducing or eliminating the opportunity for soil contact, or both;
- Delineate the potential impact that past site activities and the recent site fire may have had on the wetlands surrounding the site;
- Remediate (if necessary) the impacts that past site activities and the recent site fire may have had on the wetlands surrounding the site; and
- Minimize stormwater runoff from entering the surrounding wetlands.

Removal Action Scope

The proposed scope of the removal action consists of those areas of the Riverdale site containing media with concentrations of chemicals of potential concern (COPCs) posing total cancer risks or HIs above target levels. Target areas were defined as those which exceed the maximum acceptable cancer risk of 10^{-4} and/or a noncancer HI of 1, which are generally considered acceptable by U.S. EPA.

Removal Action Alternatives

A limited number of removal action alternatives that address the above RAOs were identified and evaluated within the scope of this EE/CA. The alternatives are as follows:

- Alternative 1: No Action—The no-action alternative was evaluated to provide a baseline to which other alternatives can be compared, as required by the NCP. Under this alternative, contaminated soils would be left in their current condition, and no further maintenance of the existing limestone cover would be performed;

- Alternative 2: Maintain Limestone Cover and Implement Institutional Controls—The current limestone cover would be maintained and institutional controls (i.e., deed restrictions) would be implemented to prevent the site from being developed for residential use, and to notify future buyers of the presence of soil contamination that exceeds generally acceptable cancer or noncancer risks.

cm/sec
centimeters per second

PRSC
post-removal site control

TSD
treatment, storage, and disposal

- Alternative 3: Install Sitewide Enhanced Asphalt Cap—This alternative would involve grading and compacting the existing limestone cover and placing a 4-inch enhanced asphalt cap over the entire site. The enhanced asphalt cap would have a maximum hydraulic permeability of 1×10^{-8} centimeters per second (cm/sec). Additionally, institutional controls and post-removal site control (PRSC) measures would be implemented;

- Alternative 4: Localized Hot Spot Removal and Installation of an Enhanced Asphalt Cap—Under this alternative, surface and subsurface soils that exceed a total cancer risk of 1×10^{-4} and/or an HI greater than 1, based on construction work exposure, would be excavated and incinerated at an off-site treatment, storage, and disposal (TSD) facility. Once the soil removal phase is complete, the excavation would be backfilled and a protective cap, consisting of an enhanced asphalt, then would be placed over the entire site; and

- Alternative 5: Excavation and Off-Site Incineration—For this alternative, surface soil and subsurface soil that exceed a total cancer risk of 1×10^{-4} and/or an HI of 1, based on industrial worker exposure, would be excavated and incinerated at a TSD facility in Canada. Deed restrictions would be implemented to prevent the site from being developed for residential use, and to notify future buyers of the presence of soil contamination, that exceeds generally acceptable cancer or noncancer risks.

Except for the no-action alternative, certain institutional controls, investigative, and construction elements would be required as part of the final selected alternative. These common components are to be considered an integral element for all of the remaining removal action alternatives:

- Institutional Controls—No residential use of the site is a basic premise underlying all of the alternatives; therefore, institutional controls, in the form of deed restrictions that prohibit residential use of the site, are an essential element of the general response measures for the site;

- Perform Ecological Sampling—Based on the findings of E & E's ecological survey, there may be potential for contaminants to be adversely affecting the surrounding ecological habitats. The previous investigations performed at the Riverdale site focused on the active industrial portion of the property. Therefore, as part of the action alternatives proposed in this EE/CA, soil, surface water, and sediment sampling with chemical analysis for the surrounding ecological habitats is included as a common component; and

- Construct a New Raw Materials Storage Area—Most of the raw chemicals used as feed material for the formulation of agricultural and turf chemicals at the Riverdale site are stored outdoors. The natural drainage of this area routes stormwater runoff through the materials storage area and into the wetland area; therefore, stormwater and runoff come into contact with the raw materials containers and then drain into the wetlands. Based on the results of the ecological survey and the need to minimize the potential adverse impact associated with the release of raw materials into the wetlands, a new raw materials storage area is included as a common component of the action alternatives.

Analysis of Removal Action Alternatives

The removal action alternatives were evaluated independently based on three broad criteria–effectiveness, implementability, and cost–established by U.S. EPA. Effectiveness refers to the degree to which an alternative would mitigate threats to public health and the environment and achieve ARARs. Implementability refers to the technical feasibility, administrative feasibility, and availability of services and materials for each alternative. Finally, capital and PRSC costs were estimated and the present worth of each alternative was calculated. Following the independent alternative evaluations against the three criteria, a comparative analysis of the alternatives was conducted to evaluate their relative performance, and to identify advantages, disadvantages, and key trade-offs that may affect removal action selection.

Recommended Sitewide Alternatives

Based on the alternative evaluation, Alternative 4 (Localized Hot Spot Removal and Install an Enhanced Asphalt Cap) is recommended as the alternative that best protects human health and the environment in a cost-effective manner. While not removing as much soil contamination as proposed in Alternative 5, Alternative 4 would greatly reduce the risk associated with construction worker exposure by removing the areas of highest soil contamination and risk. Additionally, Alternative 4 caps those areas with residual contamination that are not addressed by Alternative 5. Finally, Alternative 4 would provide a better protective barrier than does the existing limestone cover as proposed in Alternative 2.

Also included in the recommended sitewide removal action are the common action item components. Deed restrictions must be implemented to prevent residential use of the site. Ecological sampling and analysis of the off-site adjacent areas must be performed to ensure that off-site contamination (if any) is not adversely affecting ecological habitats. Additionally, raw chemicals stored outside must be placed in an area that will prevent spills and/or stormwater contact and runoff from entering the wetlands located east of the facility.

Finally, Riverdale is preparing a preliminary engineering design to upgrade the existing stormwater drainage system at the site. The enhanced asphalt cap will increase the amount of surface water runoff at the site, because it is less permeable than the existing limestone cover. If not properly drained, the increase in volume may cause operational problems at the facility and potentially increase the amount of surface water runoff to the surrounding ecological habitats. For this EE/CA, it has been assumed that the stormwater drainage system will be upgraded and that the upgrade will be compatible with the proposed removal alternatives.

The total estimated cost for implementation of the recommended sitewide removal action is $5,232,000.

2 Site Characterization

E & E
Ecology and Environment, Inc.

U.S. EPA
United States Environmental Protection Agency

RI
remedial investigation

IT
International Technology Corporation

BHHRA
baseline human health risk assessment

Riverdale
Riverdale Chemical Company

CHTT
Chicago Heights Terminal Transfer Railroad

B&O
Baltimore and Ohio Railroad

AST
aboveground storage tank

Information in this section describing the site background, previous removal actions, and the nature and extent of contamination was obtained from available file information supplied to Ecology and Environment, Inc., (E & E) by the United States Environmental Protection Agency (U.S. EPA) and from data collected during E & E's ecological site reconnaissance, unless otherwise noted. Complete documentation of the remedial investigation (RI) findings, including results of International Technology Corporation's (IT's) baseline human health risk assessment (BHHRA), are provided in the RI report (IT 1997).

2.1 Site Description and Background

2.1.1 Site Location and Physical Setting

The Riverdale Chemical Company (Riverdale), an active producer of pesticides and herbicides, is located at 220 East 17th Street in Chicago Heights, Illinois (see Figure 2-1). The Riverdale site is bordered on the north by Chicago Heights Terminal Transfer Railroad (CHTT) tracks, East 17th Street, and a low density residential area. Baltimore and Ohio Railroad (B&O) tracks and a closed asphalt roofing company are located to the east. The site's south side is bordered by the Michigan Central Railroad tracks, which run on top of a 15-foot earthen embankment, but are no longer in use. Beyond the railroad embankment to the south is an active steel processing facility. A 20-acre vacant lot, which was previously a truck manufacturing facility, is located to the west.

Riverdale, which purchased the site in 1956, has formulated various fungicide, herbicide, and insecticide products at the site, and currently formulates agricultural and insecticide products on site. Previous owners used the site for carriage building, brewing, and warehouse storage. The site consists of three main buildings which contain facilities for: pesticide production, raw material storage, and finished product storage. A smaller ancillary building and an aboveground storage tank (AST) farm also are on site. The ASTs hold the liquid compounds used in processing.

MSL
Mean Sea Level

F
Fahrenheit

The Riverdale site is approximately 10 acres in size. The site topography is relatively flat but features a gentle slope to the east. The site elevation ranges from approximately 672 feet above mean sea level (MSL) in the southwestern portion down to 664 feet MSL in the eastern portion. The southern portion of the site ranges from 683 feet to 687 feet MSL, and the eastern portion ranges from 665 feet to 667 feet MSL. The southeastern portion of the site includes a wetland area, which has no natural drainage and is assumed to be a perched system, deriving most of its water from runoff and direct precipitation (IT 1997).

2.1.2 Surrounding Land Use and Population

Chicago Heights is located along the southern border of the Chicago, Illinois, metropolitan area. The Riverdale site is in the southeast portion of Chicago Heights. While zoned for industrial use, the site is located in an area with mixed residential, commercial, and industrial land uses. An estimated 10,000 people living within 3 miles of the site are served by private wells. Nine public water supply wells serve South Chicago Heights and East Chicago Heights, and 12 industrial wells provide production water for local industries, according to the RI Report.

The estimated populations for the surrounding areas, based on the 1980 Census, are 5,253,190 for Cook County, Illinois; 522,965 for Lake County, Indiana; and 37,026 for Chicago Heights. The estimated population within a 1-mile radius of the site is 11,100, and the estimated population within a 2-mile radius, which encompasses portions of South Chicago Heights and Ford Heights, Illinois, is 29,700 (IT 1997). Additionally, a municipal landfill is located 3,500 feet south of the site.

2.1.3 Meteorology

The nearest climatological monitoring station, which is located in Park Forest, Illinois, is approximately 5 miles west of the site. Recorded weather data from 1951 to 1980 provided in the RI Report. For the area, winter temperatures averaged from 13°Fahrenheit (F) to 35°F. For a typical year, 123 days were below 32°F and 12 days had temperatures equal to or below 0°F. Typical summer temperatures averaged from 58°F to 84°F, with 18 days exceeding 90°F.

Total precipitation averaged 35.2 inches per year. There was approximately 34.2 inches of snowfall per year, and the ground was frozen approximately 148 days. Also approximately 48 days had precipitation events in excess of 0.1 inch each year.

2.1.4 Geology/Hydrology/Hydraulics

The Riverdale site is located in the Great Lakes Section of the Central Lowland Physiographic Province (IT 1997). The Great Lakes Section is a plain of Wisconsinan glacial till, which is interrupted by morainal ridges arranged in concentric arcs around the southern end of Lake Michigan.

BGS
below ground surface

Eight soil borings conducted during the RI were advanced to a maximum depth of 14 feet below ground surface (BGS) to characterize subsurface soils and to define shallow subsurface stratigraphy. The RI soil borings indicated that the site is underlain by fill material ranging from 2 feet to 5 feet in thickness. The fill material consists of gravel, cinders, ash, brick, and wood fragments. The fill is underlain by a very stiff, yellowish brown to gray, silty clay that was observed to the maximum depth of each boring conducted on site. Three of the borings encountered a thin, discontinuous sand to silty sand lense between the fill and the underlying silty clay.

The silty clay unit at the site is associated with Wisconsinan ground moraine and end moraine deposits. The deposits at the site are derived from a clay-loam-till material (Fehrenbacher et al. 1967). Area well logs indicate that the moraines, which comprise the unconsolidated deposits above bedrock, extend to a thickness of approximately 35 feet BGS. Although site soil borings were completed to a maximum depth of only 14 feet BGS, the silty clay unit encountered to this depth is assumed to continue down to the bedrock interface (IT 1997).

Bedrock at the site is Silurian-age dolomite limestone belonging to the Niagaran Formation and directly underlies the unconsolidated deposits.

Groundwater was not encountered to a maximum depth of 14 feet BGS in the borings conducted during the RI. In addition, area well logs do not indicate the presence of any coarse-grained potential water-bearing layers within the unconsolidated deposits surrounding the site.

The Niagaran Dolomite is considered the uppermost aquifer in the site area, according to well logs (IT 1997). Water levels generally are encountered at or below the top of bedrock. Groundwater flow in the Niagaran Dolomite is generally toward the southeast, although municipal and industrial pumping can affect local flow directions greatly.

The Niagaran Dolomite is underlain by shales that serve as an aquitard to underlying aquifers (IT 1997).

2.2 Previous Site Activities

2.2.1 Field Investigation Team Investigation

FIT
Field Investigation Team

VOCs
volatile organic compounds

SVOCs
semivolatile organic compounds

PAHs
polynuclear aromatic hydrocarbons

TCDD
2,3,7,8-tetrachloro-dibenzo-p-dioxin

FS
feasibility study

AOC
Administrative Order by Consent

IRM
Interim Remedial Measure

TAT
Technical Assistance Team

In April 1984, U.S. EPA tasked E & E's Field Investigation Team (FIT) to conduct a site investigation at the Riverdale site. The investigation was conducted as part of the National Dioxin Test Strategy program. The FIT collected 15 surface soil samples, which were submitted for analysis for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and dioxins. A summary of the analytical results is presented in Table 2-1, and Figure 2-2 depicts the sampling locations.

The results revealed contamination of the surface soil by various pesticides; VOCs; polynuclear aromatic hydrocarbons (PAHs); phenolic compounds; and 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD). Based on the findings of the FIT investigation and the proximity of the site to residential areas, a more complete delineation of the extent of contamination was deemed necessary, and U.S. EPA entered into negotiations with Riverdale to perform an RI and a feasibility study (FS) at the site.

2.2.2 Interim Remedial Measures

As a result of the FIT investigation findings and as part of the Administrative Order by Consent (AOC) between Riverdale and U.S. EPA, dated September 28, 1984, an interim remedial measure (IRM) was initiated. The IRM consisted of placing a geofabric liner and a layer of crushed limestone over approximately 20,000 square yards of the site. The cover was placed over soils that were determined to contain the highest levels of contamination. Riverdale has continued to maintain this cover to date by trucking in limestone. The current thickness of the limestone cover has been estimated by Riverdale personnel to be approximately 1 foot thick.

2.2.3 Emergency Response

On July 2, 1992, E & E's Technical Assistance Team (TAT) was tasked by U.S. EPA to provide emergency technical support to a fire response at the Riverdale site. The fire began after a 10,000-square-foot warehouse was struck by lightning. The warehouse included the possible combustible materials hydrogen chloride, phosgene, sulfur dioxide, and hydrogen sulfide.

Before the arrival of TAT personnel, the fire had been confined to the warehouse and water runoff had been confined to the Riverdale property. In order to contain the runoff on site, water was directed to ponds formed by the railroad rights-of-way, to a berm located 5 feet from the warehouse of concern, and later to a berm located in the southernmost portion of the property.

During the TAT emergency response, the following work was performed:

- Air monitoring for toxic chemicals, including phosgene, hydrogen chloride, hydrogen sulfide, and sulfur dioxide, was conducted. No readings above background levels were observed;

- Testing of the water runoff for pH was performed at regular intervals. Results indicated a pH of 5.7 standard units (S.U.). In addition, a field test for nickel and nitrate was completed in response to visual observations of runoff flowing to the east of the warehouse. The test results were negative;

- On July 3, 1992, water samples were collected from the runoff pools located along the railroad tracks east of the warehouse. The samples were analyzed on site by Riverdale personnel. Because 2,4-D was detected above U.S. EPA limits, the Illinois Environmental Protection Agency (Illinois EPA) was notified and further testing of water runoff was conducted at two nearby storm sewers. Results of the analysis of water from the storm sewers indicated that there was not a threat to fish in Thorn Creek, the recipient of the stormwater runoff;

- Once the fire had burned out, the fire department requested a track hoe for use in extinguishing the remaining smoldering debris. While the track hoe was used, the only detectable air monitoring reading of 0.5 part per million (ppm) was recorded for sulfur dioxide.

S.U.
standard units

Illinois EPA
Illinois Environmental Protection Agency

ppm
parts per million

ATSDR
Agency for Toxic Substances and Disease Registry

By the end of July 1992, all smouldering debris was extinguished. TAT personnel remained on site for support work. Cleanup activities were monitored by the Illinois EPA.

2.2.4 Agency for Toxic Substances and Disease Registry Study

In 1996, E & E's TAT was tasked by U.S. EPA to collect off-site residential soil samples as part of a study sponsored by the Agency for Toxic Substances and Disease Registry (ATSDR). TAT col-

BNAs
base/neutral and acid extractable organic compounds

PCBs
polychlorinated biphenyls

mg/kg
milligrams per kilogram

DDT
dichloro-diphenyl-trichloroethane

HSL
Hazardous Substance List

lected three surface soil samples and one duplicate from residences immediately north of the Riverdale site. The samples were submitted for laboratory analysis. Compounds analyzed for were base/neutral and acid extractable organic compounds (BNAs), chlorinated organic pesticides, and polychlorinated biphenyls (PCBs). The soil samples were not analyzed for dioxins.

Analytical results for the soil samples revealed PAHs at 1.4 milligrams per kilogram (mg/kg). Additionally, the analysis detected chlordane (maximum concentration 0.52 mg/kg), dichloro-diphenyl-trichloroethane (DDT) (maximum concentration 0.041 mg/kg), dieldrin (maximum concentration 0.55 mg/kg), and heptachlor epoxide (maximum concentration 0.31 mg/kg).

The study concluded that the contaminant concentrations detected in the soil samples collected from the residential yards do not pose a public health hazard.

2.3 Source, Nature, and Extent of Contamination

This section briefly summarizes the results of the field investigation conducted by IT between October 1985 and November 1986 as part of the RI for the Riverdale site. The RI-field investigation was conducted in two phases. Phase I activities consisted of collecting subsurface soil samples from eight soil borings, as well as 21 surface soil samples. As part of the sampling and analysis procedures employed during the Phase I field effort, the 21 surface soil samples were composited into six samples, which were then analyzed for Hazardous Substance List (HSL) organic and pesticide compounds. Soil from eight of the surface soil sampling locations along the northern site property line was combined to create two composite samples. Surface soil samples from the remaining 13 locations, plus the two composite samples for a total of 15 surface soil samples, were submitted for dioxin analysis.

Additionally, 16 subsurface soil samples collected from the eight soil borings were composited into four samples, which were then submitted for HSL organic and pesticide analysis. All of the subsurface soil samples were submitted for dioxin analysis. In addition to the soil samples, breathing-zone air samples and one grab and two composite sanitary sewer effluent samples were collected.

Phase II activities included collection and analysis of 19 surface soil samples. Twelve of the 19 samples were submitted for dioxin analysis, and 16 were submitted for HSL pesticide analysis. Figure 2-2 depicts the sampling locations.

2.3.1 Surface Soil Sample Results

µg/kg
micrograms per kilogram

BHC
benzenehexachloride

The analytical results for surface soil samples collected during the RI revealed VOCs, SVOCs, pesticides, and dioxin. In general, surface soil contamination is widespread across the site. Maximum detected concentrations of VOCs ranged from 3.5J micrograms per kilogram (µg/kg) for chlorobenze to 14J µg/kg for toluene. The J qualifier indicates an estimated quantity. For SVOCs, the maximum concentrations ranged from 120 J µg/kg for dibenzofuran to 6,800 µg/kg for pyrene. While not reported in the table, it should be noted that vinyl chloride and methylene chloride were detected in the surface soil samples. However, these VOCs were also detected in trip blanks, and their presence was determined to be caused by a laboratory artifact. VOC and SVOC analyses were performed for samples collected during Phase I. Addtionally, all of the samples submitted for VOC and SVOC analyses were composite samples. Therefore, the analytical results are average values, and soil from at least three locations was collected to create individual composite samples. Table 2-2 summarizes the analytical results from the surface soil investigation.

Maximum detected concentrations of pesticides in the surface soil ranged from 130 µg/kg of gamma-benzenehexachloride (BHC) (lindane) to 1,100,000 µg/kg of chlordane. The maximum detected concentration of chlordane occurred in a composite sample comprising materials from different locations (SS15 and SS16).

Dioxin was detected in 19 surface soil grab samples, which were collected across the site. Detected dioxin concentrations ranged from 0.18 µg/kg to 197 µg/kg. The maximum dioxin concentration was also detected in sample SS15.

2.3.2 Subsurface Soil Sample Results

Subsurface soil sampling and analysis were conducted during Phase I only. Soil borings were performed only in the south-half of the site, and a total of eight borings were advanced to a maximum depth of 14 feet BGS. For each boring, soil samples from two distinct intervals were submitted for 2,3,7,8-TCDD analysis. Additionally, one duplicate sample was also submitted for 2,3,7,8-TCDD analysis (total of 17 samples). HSL organic analysis was also performed for 4 composite samples. Each composite sample consisted of soil taken from two borings, with each soil aliquot collected from the same vertical interval. It should be noted that while the total depth of each boring was 14 feet BGS, the deepest interval submitted for dioxin analysis was collected from the 6.5 foot to 8.0 foot BGS interval. Additionally, all samples submitted for organic analysis were collected from either the 0 to 1.5 foot BGS interval or the 1.5 foot to 3.0 foot BGS interval. The analytical results for the subsurface soil sampling are included in Table 2-3.

Of the four composite samples submitted, samples indicated the presence of three VOCs. The VOCs and their maximum concentrations were chlorobenzene (3.5 J µg/kg), tetrachloroethene (4.3 J µg/kg), and toluene (14 µg/kg). The maximum detected VOC concentrations were in the composite sample, which consisted of soil from borings SB03 and SB04 collected from 0 feet to 1.5 feet BGS.

Eighteen SVOCs were detected in the four composite subsurface soil samples. The maximum detected concentrations ranged from 150 J µg/kg for acenaphthene to 8,700 µg/kg for pyrene. The maximum detected concentrations for 14 of the SVOCs were found in composite sample SB(07, 08), which was collected from the 0- to 1.5-foot-BGS interval. Maximum concentrations of naphthalene, fluorene, and 2-methylnaphthalene were detected in composite sample SB(03,04), and the maximum detected concentration of butylbenzylphthalate was detected in composite sample SB(01,02).

DDE
dichloro-diphenyl-dichloroethylene

Pesticides were detected in all of the subsurface composite samples. While nine different pesticides were detected, only 4,4'-DDT and dieldrin were detected in all of the composite samples. The maximum concentration of pesticides ranged from 160 µg/kg for heptachlor epoxide to 200,000 µg/kg for dieldrin. Except for 4,4'-dichloro-diphenyl-dichloroethylene (DDE) and heptachlor epoxide, the maximum concentrations for all detected pesticides were found in composite sample SB(05,06), which was collected from the 1.5- to 3-foot-BGS interval. The maximum detected concentrations of 4,4'-DDE and heptachlor epoxide were found in composite sample SB(03,04), which was collected from the 0- to 1.5-foot-BGS interval.

Dioxin was detected in five of the 20 individual subsurface samples submitted for analysis. The maximum detected concentration of 2,3,7,8-TCDD was 33.7 µg/kg in SB06 from the 0- to 3.0-foot-BGS interval. Of the four samples with dioxin detected, three were from the 0- to 3-foot-BGS interval. Of the seven samples collected from depths greater than 4.5 feet BGS, one sample (SB06) revealed dioxin. SB06 was collected from the 6.5- to 8-foot-BGS interval and had dioxin at 0.8 µg/kg.

2.3.3 Air Sample Results

Two breathing-zone air samples were collected using personal air monitors. Air was collected for a nine hours during surface soil sampling. The air samples then were submitted for 2,3,7,8-TCDD analysis, and analytical results were nondetect for dioxin.

2.3.4 Sanitary Sewer Sample Results

The Thorn Creek Sewerage District, which receives stormwater runoff and noncontact cooling water from the Riverdale site, requested a grab effluent sample. On November 20, 1985, Riverdale personnel collected the grab sample and submitted it for 2,3,7,8-TCDD analysis.

ppt
parts per trillion

The grab effluent sample was collected from a manhole on the east side of the main building, and the analytical results indicated 2.4 parts per trillion (ppt) of 2,3,7,8-TCDD. The RI Report indicates that composite samples collected on June 13, 1986, and January 7, 1987, were nondetect for 2,3,7,8-TCDD.

Table 2-1

SUMMARY OF SOIL ANALYTICAL RESULTS FROM
FIELD INVESTIGATION TEAM (FIT) INVESTIGATION
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS
(μg/kg)

Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Location of Maximum Detected Concentration
Volatile Organic Compounds				
1,1,2,2-Tetrachloroethane	5 J	5 J	2/14	B-6
4-Methyl-2-pentanone	20 J	20 J	1/14	B-6
Chloroform	5 J	14	2/14	B-6
Ethylbenzene	5 J	25	2/15	B-14
Methylene chloride	10	120	6/15	B-5
Styrene	5 J	5 J	1/14	B-2
Tetrachloroethene	4.3	5 J	2/15	B-1
Toluene	4.6 J	4.6 J	1/15	B-14
Xylenes, total	5 J	94	2/15	B-14
Semivolatile Organic Compounds				
1,2,4-Trichlorobenzene	870	870	1/15	B-10
2,4,5-Trichlorophenol	9,500	9,500	1/15	B-7
2,4,6-Trichlorophenol	330 J	4,500	5/15	B-7
2,4-Dichlorophenol	330 J	22,000	3/15	B-7
2-Methylnaphthalene	330 J	19,000	5/15	B-14
4-Chloroaniline	36,000	36,000	1/15	B-5
Acenaphthene	430	430	1/15	B-8
Acenaphthylene	330 J	470	2/15	B-9
Benzo(a)anthracene	330 J	2,700	8/15	B-7
Benzo(a)pyrene	330 J	890	4/15	B-8
Benzo(b)fluoranthene	330 J	3,700	7/15	B-8
Benzo(g,h,i)perylene	330 J	850	3/15	B-9
Benzo(k)fluoranthene	330 J	3,700	6/15	B-8
Bis(2-ethylhexyl)phthalate	330 J	1,100	3/15	B-13
Chrysene	330 J	1,300	9/15	B-4
Di-n-octylphthalate	5,100	5,100	1/15	B-12
Fluoranthene	120	2,200	9/15	B-8
Hexachlorobenzene	330 J	330 J	1/15	B-9
Indeno(1,2,3-cd)pyrene	330 J	330 J	2/15	B-10
Isophorone	330 J	330 J	1/15	B-10
Naphthalene	330 J	6,400	5/15	B-14
Phenanthrene	330 J	1,700	8/15	B-8
Phenol	330 J	330 J	1/15	B-2
Pyrene	330 J	2,200	11/15	B-4
Pesticides				
4,4'-DDD	57	990	3/14	B-8
4,4'-DDE	190	9,300	5/14	B-3

Key at end of table.

Table 2-1

SUMMARY OF SOIL ANALYTICAL RESULTS FROM
FIELD INVESTIGATION TEAM (FIT) INVESTIGATION
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS
(µg/kg)

Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Location of Maximum Detected Concentration
Pesticides (Cont.)				
4,4'-DDT	210	1,400	5/14	B-8
Aldrin	300	71,000	12/14	B-7
Chlordane, technical	78	310,000	9/14	B-3
Dieldrin	45	78,000	13/14	B-3
Heptachlor	220	190,000	9/14	B-2
Toxaphene	160,000	160,000	1/14	B-1
Dioxins				
2,3,7,8-TCDD	0.76	364	12/14	B-7

Key:

DDD = Dichloro-diphenyl-dichloroethane.
DDE = Dichloro-diphenyl-dichloroethylene.
DDT = Dichloro-diphenyl-trichloroethane.
J = Estimated Concentration.
µg/kg = Miscrograms per kilogram.
TCDD = Tetrachlorodibenzo-p-dioxin.

Table 2-2

SUMMARY OF SURFACE SOIL ANALYTICAL DATA FROM REMEDIAL INVESTIGATION ENGINEERING EVALUATION/COST ANALYSIS RIVERDALE CHEMICAL COMPANY CHICAGO HEIGHTS, ILLINOIS (µg/kg)

Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Location of Maximum Detected Concentration
Volatile Organic Compounds				
Acetone	68	68	1/6	SS(01,02,17,18)
Chlorobenzene	2.10 J	2.1 J	1/1	SS(08,09,10,11)
Ethylbenzene	2.45 J	2.45 J	1/6	SS(04,05,06,07)
Tetrachloroethene	3.9 J	3.9 J	1/6	SS(08,09,10,11)
Toluene	1.60 J	1.6 J	1/1	SB(03,04)
Xylenes, total	31.5	31.5	1/6	SS(04,05,06,07)
Semivolitale Organic Compounds				
2,4-Dichlorophenol	495	495	1/6	SS(04,05,06,07)
2-Methylnaphthalene	290 J	640	2/6	SS(03,19,20,21)
2-Methylphenol	305 J	305 J	1/6	SS(04,05,06,07)
Acenaphthylene	240 J	260	2/6	SS(04,05,06,07)
Anthracene	335	490	2/6	SS(03,19,20,21)
Benzo(a)anthracene	1,150	2,400	3/6	SS(03,19,20,21)
Benzo(a)pyrene	200	2,000	4/6	SS(03,19,20,21)
Benzo(b)fluoranthene	1,135	2,500	3/6	SS(12,13,14)
Benzo(g,h,i)perylene	775	1,200	3/6	SS(12,13,14)
Benzo(k)fluoranthene	1,135	2,500	3/6	SS(12,13,14)
Bis(2-ethylhexyl)phthalate	320	2,100 J	4/6	SS(01,02,17,18)
Butylbenzylphthalate	500	880	3/6	SS(03,19,20,21)
Chrysene	1,500	4,100	3/6	SS(12,13,14)
Dibenzofuran	120 J	120 J	3/6	SS(12,13,14)
Fluoranthene	765	5,000 J	6/6	SS(01,02,17,18)
Fluorene	182.5 J	190	2/6	SS(12,13,14)
Indeno(1,2,3-cd)pyrene	710	1,300	3/6	SS(12,13,14)
Naphthalene	170 J	300 J	2/6	SS(03,19,20,21)
Phenanthrene	785	4,900	3/6	SS(03,19,20,21)
Pyrene	1,000	6,800	3/6	SS(12,13,14)
Pesticides				
4,4'-DDD	20	37,000	1/22	SS(01,02,17,18)
4,4'-DDE	140	4,900	7/10	SS(01,02,17,18)
4,4'-DDT	93	33,000	18/22	SS(15,16)
Aldrin	18	530,000	21/22	SS(15,16)
alpha-BHC	14	2,600	4/10	SS(15,16)
beta-BHC	21	2,400	3/6	SS(01,02,17,18)
Chlordane, technical	130	1,100,000	22/22	SS(15,16)
Dieldrin	49	210,000	21/22	SS(08,09,10,11)

Key at end of table.

Table 2-2

SUMMARY OF SURFACE SOIL ANALYTICAL DATA FROM REMEDIAL INVESTIGATION
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS
(μg/kg)

Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Location of Maximum Detected Concentration
Pesticides (Cont.)				
Endrin	110	5,100	3/16	SS43
Endrin ketone	77	13,000	14/22	SS11-2
BHC (lindane)	11	130	5/22	SS43
Heptachlor	18	64,000	21/22	SS(15,16)
Heptachlor epoxide	46	3,000	14/22	SS36
Methoxychlor	3,400	3,556	2/18	SS(04,05,06,07)
Dioxin				
2,3,7,8-TCDD	0.18	197	19/29	SS15

Key:

BHC = Benzenehexachloride.
DDD = Dichloro-diphenyl-dichloroethane.
DDE = Dichloro-diphenyl-dichloroethylene.
DDT = Dichloro-diphenyl-trichloroethane.
J = Estimated Concentration.
μg/kg = Micrograms per kilogram.
TCDD = Tetrachlorodibenzo-p-dioxin.

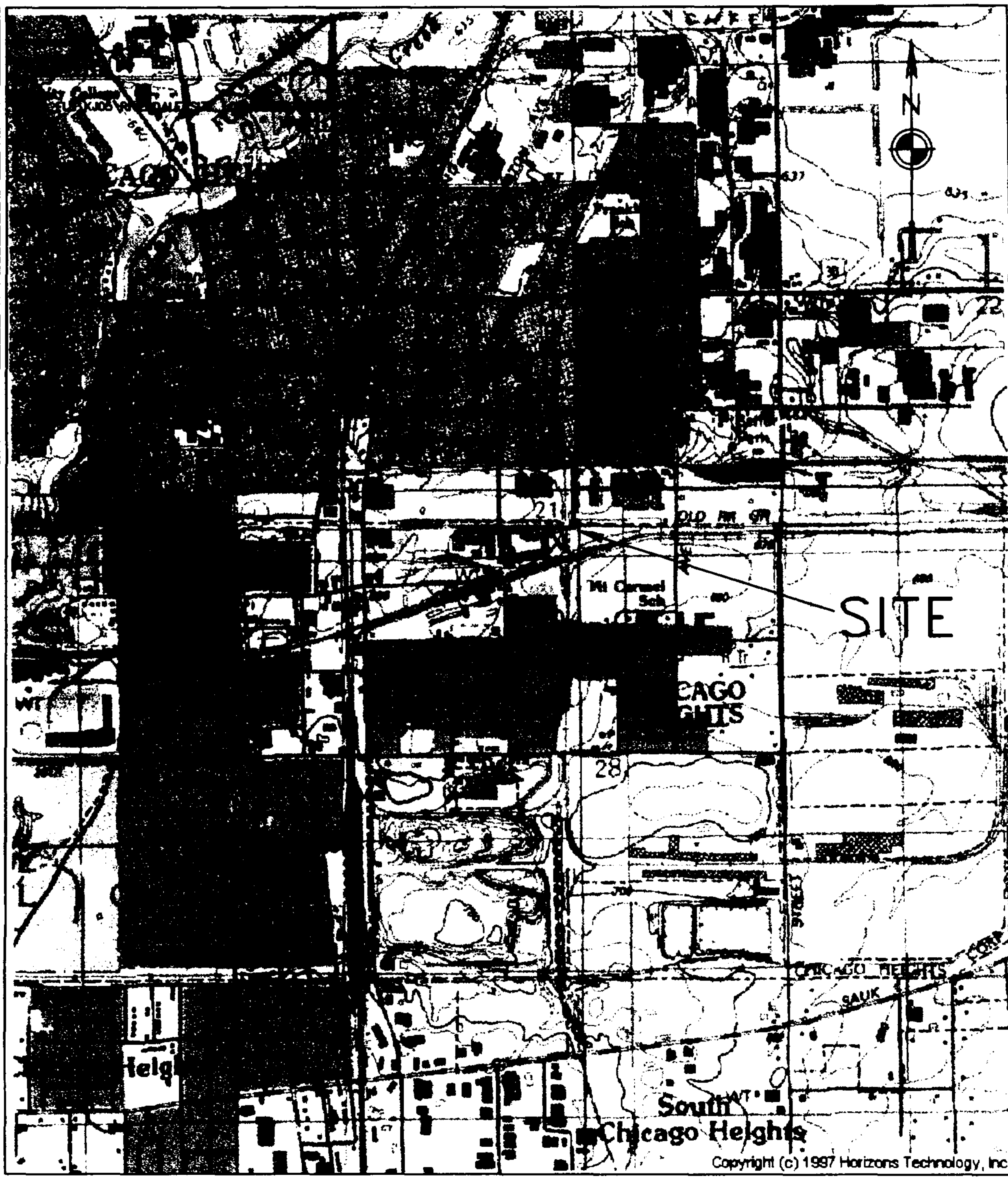
Table 2-3

SUMMARY OF SUBSURFACE SOIL ANALYTICAL DATA FROM REMEDIATION INVESTIGATION ENGINEERING EVALUATION/COST ANALYSIS RIVERDALE CHEMICAL COMPANY CHICAGO HEIGHTS, ILLINOIS (µg/kg)

Contaminant	Minimum Detected Concentration	Maximum Detected Concentration	Frequency of Detection	Location of Maximum Detected Concentration
Volatile Organic Compounds				
Chlorobenzene	3.5 J	3.5 J	1/4	SB(03,04)
Tetrachloroethene	1.8 J	4.3 J	2/4	SB(03,04)
Toluene	4.0 J	14	3/4	SB(03,04)
Semivolitale Organic Compounds				
Acenaphthene	150 J	150 J	2/4	SB(07,08)
Acenaphthylene	95 J	260	3/4	SB(06,07)
Anthracene	150 J	1,100	3/4	SB(07,08)
Benzo[a]anthracene	380	5,800	3/4	SB(07,08)
Benzo[a]pyrene	410	4,000	3/4	SB(07,08)
Benzo[b]fluoranthene	390	2,800	3/4	SB(07,08)
Benzo[g,h,i]perylene	240 J	1,900	3/4	SB(07,08)
Benzo[k]fluoranthene	390	2,800	3/4	SB(07,08)
Bis(2-ethylhexyl)phthalate	180 J	450	3/4	SB(03,04), SB(07,08)
Butylbenzylphthalate	610	1,400	3/4	SB(01,02)
Chrysene	500	6,100	3/4	SB(07,08)
Fluoranthene	560	7,200	3/4	SB(07,08)
Fluorene	320 J	320 J	1/4	SB(07,08)
Indeno[1,2,3-cd]pyrene	210 J	1,900	3/4	SB(07,08)
2-Methylnaphthalene	250 J	720	3/4	SB(03,04)
Naphthalene	160 J	520	3/4	SB(03,04,)
Phenanthrene	640	4,900	3/4	SS(07,08)
Pyrene	700	8,700	3/4	SB(07,08)
Pesticides				
4,4'-DDD	220	18,000	2/4	SB(05,06)
4,4'-DDE	52	630	2/4	SB(03,04)
4,4'-DDT	120	2,300	4/4	SB(05,06)
Aldrin	3,700	170,000	2/4	SB(05,06)
Chlordane, technical	210	46,000	3/4	SB(05,06)
Dieldrin	74	200,000	4/4	SB(05,06)
Endrin ketone	100	4,700	2/4	SB(05,06)
Heptachlor	2,700	7,800	2/4	SB(05,06)
Heptachlor epoxide	93	190	2/4	SB(03,04)
Dioxin				
2,3,7,8-TCDD	0.80	33.7	5/20	SB06-8.0

Key:

J	=	Estimated Concentration.
mg/kg	=	Micrograms per kilogram.
DDD	=	Dichloro-diphenyl-dichloroethane.
DDE	=	Dichloro-diphenyl-dichloroethylene.
DDT	=	Dichloro-diphenyl-trichloroethane.
TDD	=	Tetrachlorordibenzo-p-dioxin.



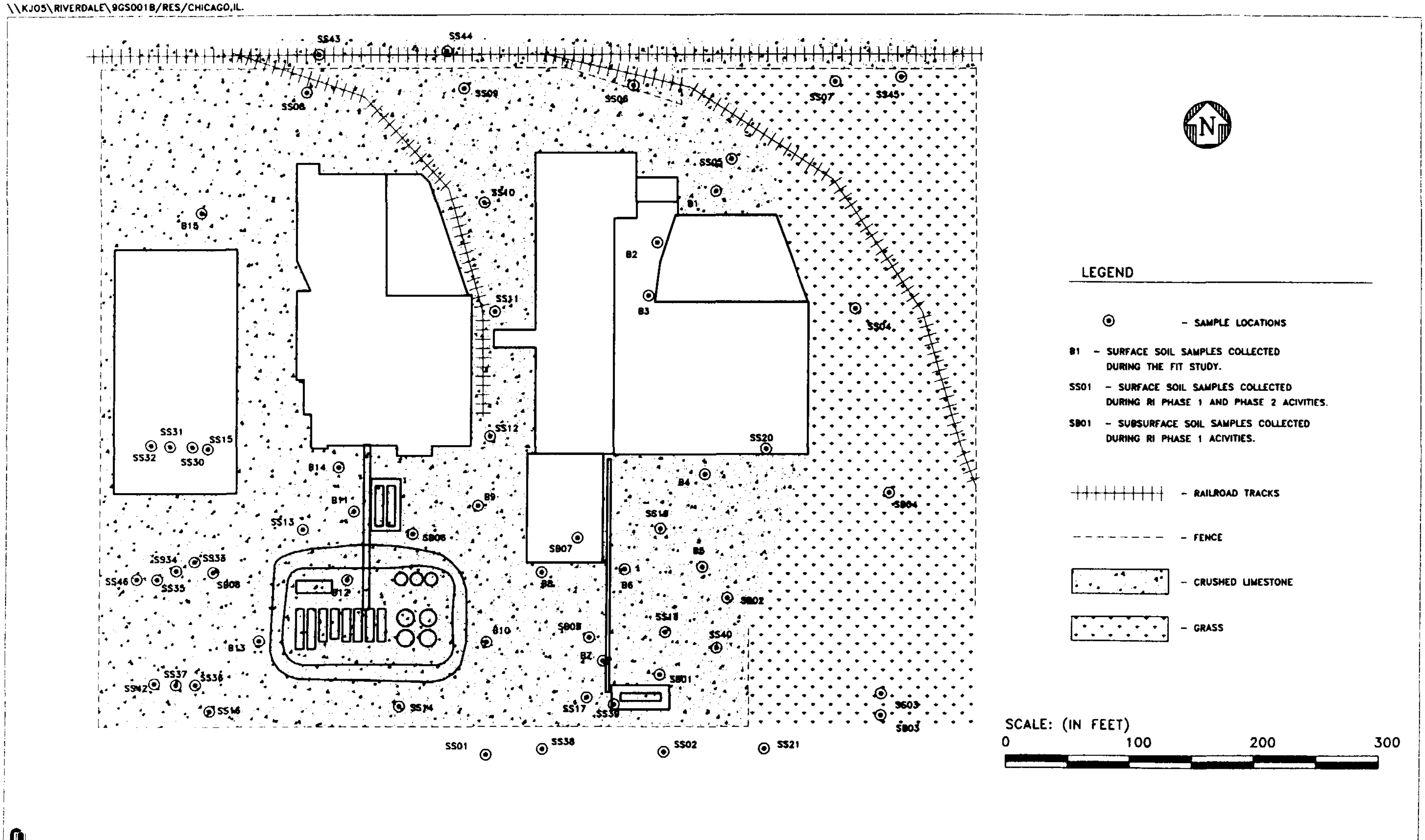
SOURCE: USGS 7.5 Minute Topographical Maps, Calumet City, IL. Quadrangle, 1968, Photorevised 1980; Dyer, IL. Quad, 1962, Photorevised 1973; Harvey, IL. Quad, 1963, Photorevised 1973, Updated 1978; and, Steger, IL. Quad 1953, Photorevised 1973.

QUADRANGLE LOCATION

SCALE = 1:24,000

FIGURE 2-1 - SITE LOCATION MAP
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

\\KJ05\RIVERDALE\9GS001B/RES/CHICAGO,IL.



ecology and environment

FIGURE 2-2 SOIL SAMPLE LOCATIONS
RIVERDALE CHEMICAL CO.
CHICAGO HTS., IL.

3 Streamlined Risk Evaluation

SRE
Streamlined Risk Evaluation

EE/CA
Engineering Analysis/Cost Analysis

RAGS
Risk Assessment Guidance for Superfund

SERE
Streamlined Ecological Risk Evaluation

U.S. EPA guidance on conducting non-time-critical removal actions requires that a streamlined risk evaluation (SRE) be included as a component of the Engineering Analysis/Cost Analysis (EE/CA) in order to assist in determining whether a removal action is required, and to identify the potential current and future exposures that should be prevented. The SRE is intermediate in scope between the limited risk evaluation performed for a removal action and the conventional baseline risk assessment conducted for remedial actions. The SRE is intended to evaluate the existing and potential risks posed by the specific problem that the removal action is intended to address, and can be both qualitative and quantitative in nature (U.S. EPA 1993a).

The purpose of this SRE is to assess the potential risks posed to human and environmental receptors from exposure to the contaminants detected in soil at the Riverdale site. Soil and possible sediment contamination is the concern at the site.

The human health and ecological SREs were prepared and organized in general accordance with U.S. EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (U.S. EPA 1989a); U.S. EPA's *Framework for Ecological Risk Assessment* (U.S. EPA 1992a); and other related guidance.

3.1 Streamlined Ecological Risk Evaluation

This streamlined ecological risk evaluation (SERE) for the Riverdale site was conducted in accordance with *Risk Assessment Guidance of Superfund*, Volume II, Environmental Evaluation Manual, EPA/540/1-89/001 (U.S. EPA 1989b) and *Guidelines for Ecological Risk Assessment*, EPA/630/R-95/002F (U.S. EPA 1998a).

3.1.1 Introduction

3.1.1.1 Purpose

COPECs
contaminants of potential ecological concern

The purpose of the SERE for the Riverdale site is to evaluate the ecology of the site and the surrounding area to identify the contaminants of potential ecological concern (COPECs) that are associated with the site, to evaluate the pathways and the extent to which ecological receptors might be exposed to these chemicals, and to assess the ecological effects associated with exposures to the chemicals.

3.1.1.2 Scope

According to U.S. EPA (1998a) guidance, the ecological risk assessment process is divided into five major components: problem formulation, ecological data acquisition and review, exposure assessment, ecological effects assessment, and risk characterization. Because this is a streamlined risk evaluation and not a complete baseline risk assessment, several components of the risk assessment process were combined, and some process steps that are usually quantitative in nature are addressed qualitatively.

To satisfy the goals of the SERE, data collected at the Riverdale site for the RI (IT 1997) were utilized. In addition, wetlands maps, topographic quadrangles, soil maps, and state and federal lists of species of potential concern were reviewed. A limited ecological field reconnaissance also was conducted to confirm and supplement the findings of the literature review and previously obtained site information. The field reconnaissance for the SERE was conducted on October 12, 1999, and included:

- Documentation of physical characteristics of habitats identified as potential receptors;
- Confirmation of identifiable resource boundaries;
- Observations of dominant vegetation and wildlife species or communities;
- Documentation of species of potential regulatory concern;
- Identification of surface water drainage patterns;
- Observation of general land use in the vicinity of the site; and
- Identification of potential sources of contamination not related to the site.

Photographs were taken during the field reconnaissance to document site conditions. The photographs and a map showing their location and direction are included in this report as Appendix A. The SERE for the Riverdale site is presented in two major sections. The environmental resources of the site and the surrounding area are described in Section 3.1.2. The potential risks to the environmental resources are presented in Section 3.1.3.

3.1.1.3 Ecological Assessment Area

The ecological assessment focused on the 10-acre Riverdale Chemical Company property; however, the land uses, habitat types and the presence or absence of important ecological resources such as surface water bodies, floodplains and wetlands in the site vicinity also were considered in the assessment. The Riverdale site encompasses approximately 10 acres of land within an industrialized area zoned for heavy industry in the southeastern portion of Chicago Heights. The site is bounded on the north by CHTT tracks, East 17th Street and residences; on the east by B&O tracks; on the south by Michigan Central Railroad tracks, and on the west by a vacant lot. The site is fenced on the north, west, and east sides. The fence on the south side recently was taken down to allow for addition of gravel and had not been replaced by the October 12, 1999, site reconnaissance.

3.1.2 Environmental Resources Inventory

A literature review and a limited field reconnaissance were conducted to document the following environmental resources on the 10-acre Riverdale site and in the surrounding area:

- Surface water resources (streams, ponds, wetlands, floodplains, and surface water drainage);
- Habitats;
- Species of Potential Concern;
- Geology and Hydrogeology;
- Soils;
- Topography;
- Land Use; and
- Climate.

3.1.2.1 Surface Water Resources

USFWS
United States Fish and Wildlife Service

NWI
National Wetlands Inventory

HUD
U. S. Department of Housing and Urban Development

To assess the surface water resources on and adjacent to the Riverdale site, the United States Fish and Wildlife Service (USFWS), National Wetlands Inventory (NWI) maps of Harvey, Illinois (April 1984a); Calumet City, Illinois-Indiana (May 1983a); Steger, Illinois (April 1984b); and Dyer, Illinois-Indiana (April 1983b); along with the United States Department of Housing and Urban Development (HUD 1979), Floodway Boundary and Floodway Map, City of Chicago Heights, Illinois were reviewed. A limited field reconnaissance also was performed to verify surface water resources. Wetland types have been classified in accordance with *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).

Streams

There are no streams on the Riverdale site, but a tributary to Thorn Creek lies 0.5 mile south and 1 mile east of the site.

A drainage ditch is located along the southern edge of the site, along the northern toe of the railroad bed.

No fish or amphibians were observed in the drainage ditch at the time of the site visit. Filamentous algae were observed distributed in the ditch. However, observations of many toads in the vicinity of the drainage ditch by Riverdale employees during spring 1999 may indicate that this habitat is important to amphibians.

Ponds

The NWI maps do not identify any ponds on the Riverdale site; however, a small pond is located approximately 500 feet northeast of the site.

Wetlands

The NWI maps of Harvey, Illinois (USFWS 1984a); Calumet City, Illinois-Indiana (USFWS 1983a); Steger, Illinois (USFWS 1984b); and Dyer, Illinois-Indiana (USFWS 1983b), do not identify wetland habitats on the Riverdale site.

A small area that is likely a wetlands area was observed on the Riverdale site, immediately east and southeast of the raw materials storage pad during the field reconnaissance. The area is a low-lying pocket that collects runoff from the raw materials storage pad and the southeastern corner of the site. The area is less than 1 acre and is dominated almost exclusively by Common Cattail *(Typha latifolia)* and Water-Flaxseed *(Spirodela polyrhiza)*. Plant species also include Red Maple (Acer rubrum), Cottonwood (*Populus deltoides),* and an ash species (*Fraxinus spp.*) (see photographs 1, 2, 12, 14, 15, and 16 in Appendix A).

No formal wetlands delineation was performed at the Riverdale site as part of this investigation.

Conversations with employees at Riverdale indicated that during spring 1999, many small toads were observed near the wetlands, which may indicate that the site is an important amphibian habitat.

Workers also have seen wood ducks, mallards, racoon, opossum, and red fox in the same area.

Floodplains

The 100-year floodplain is defined by state and local regulations as those areas mapped by the HUD National Flood Insurance Program, in the form of a Floodway Boundary and Floodway Map. In general, floodway maps identify all land within reach of a flood with a 1% probability of occurring in any given year (also referred to as the base flood [Kusler and Platt 1988]). Floodplains occur in areas along or adjacent to streams or bodies of water that are capable of storing or conveying floodwater.

The HUD (1979) floodway map for Chicago Heights, Illinois, shows the entire Riverdale site to be outside of flood zones.

Surface Water Drainage Patterns

Surface water drainage patterns on and in the vicinity of the Riverdale site were estimated based on field observations and topographic maps. The surface water drainage patterns are shown in Figure 3-1. Most of the surface water runoff at the Riverdale site flows to the southeast, toward the wetlands area located on the southeastern portion of the site. Much of the surface water runoff that enters the wetlands has traveled over contaminated areas of the site and over the raw materials storage area. On the west side of the site, the surface water drainage flows toward the southwest. Much of the surface water drainage in the northern portion of the site flows toward the south to a sanitary sewer located between Buildings #1 and #3.

3.1.2.2 Habitats

Habitat types on site were identified during the field reconnaissance. The major habitat types are shown in Figure 3-2 and include the following:

- Mowed field,
- Old field,
  - Perennial Herbaceous-Woody-Plant Community,
  - Perennial Herbaceous Plant Community,
- Wetland, and
- Barren.

The areas surrounding the Riverdale site are dominated by the same ecological habitats as those on site, as well as mixed deciduous forest.

The vegetation observed in each habitat is listed in Table 3-1. Amphibians and reptiles that may exist in each habitat listed in Table 3-2. The birds and mammals that are known to exist or may exist on site are listed in Tables 3-3 and 3-4, respectively.

Mowed Field

Mowed field habitat on the Riverdale site exists along the entire west side. This habitat comprises approximately 0.75 acre of the 10-acre site.

The habitat consists of grasses (*Gramineae spp.),* Common Ragweed *(Ambrosia artemisiifolia)*, and various weeds that are managed through periodic application of an herbicide. The local fire department has required maintenance of a fire break along the outside of the fence for the site. Riverdale personnel periodically apply the herbicide to the outside of the fence to keep the vegetation low to the ground. The continued application of the herbicide to this area will prevent this habitat from developing into an old field habitat. This habitat is considered to be low ecological habitat.

- **Perennial Herbaceous Plant Community**

  Fields that range in age from three years to 10 years post-disturbance usually are dominated by perennial herbaceous plant communities. Most of the eastern end of the site can be characterized as a perennial herbaceous community. The community has an abundance of perennial herbaceous and grass species. The goldenrods and asters that usually dominate a two- to three-year, post-disturbance field no longer uniformly cover the field, and seedlings of shrub and tree species begin to grow (Kricher and Morrison 1988).

  Observations of the vegetation in this community on site included the following species: goldenrod (*Solidago spp.),* Queen Anne's Lace (Daucus carota), aster (*Aster spp.*), and grasses (*Gramineae spp.*). The animal species that were observed in this habitat included American Goldfinch (*Carduelis tristis*), House Finch (*Carpodacus mexicanus*), Purple Finch (*Carpodacus purpureus*), and Mourning Dove *(Zenaida macroura)*. In addition, Raccoon (*procyon lotor*) tracks were observed within the old field habitat at the eastern edge of the site.

- **Perennial Herbaceous-Woody-Plant Community**
  Fields that range in age from 10 years to 60 years post-abandonment usually are dominated by perennial herbaceous-woody-plant communities. The western edge of the site and the property immediately west of the site can be characterized as a perennial herbaceous-woody-plant community. In these communities, herbs and grasses are much less obvious compared to the younger communities. Clumps of trees and shrubs shade the ground. Large patches of trees and shrubs are interrupted by areas of grass. The habitat is very patchy in appearance. Very old fields begin to look like woodlands, with dense clumps of slender trees (Kricher and Morrison 1988).

  Observations of the vegetation in this community on site included the following species: Milkweed (*Asclepias syriaca*), Eastern Cottonwood (*Populus deltoides*), Aster species (*Aster spp.)*, Bull Thistle (*Cirsium vulgare*), Black Cherry (*Prunus serotina)*, and Honey Locust (*Gleditsia triancanthos*). The animal species observed in the habitat included Mourning Dove *(Zenaida macroura)* and Field Sparrow (*Spizella pusilla*).

Wetlands

The wetland community comprises approximately 1 acre in the east portion of the 10-acre Riverdale site.

"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominately undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season (Cowardin et al. 1979)."

The United States Army Corps of Engineers, which has authority over the wetlands, defines wetlands in its Wetlands Delineation Manual (USACE 1987). This manual defines regulated wetlands as having these characteristics: 1) a predominance of hydrophytic vegetation; 2) saturated soil conditions; and 3) inundated or saturated groundwater at or near the surface. NWI maps categorize wetlands as areas having one of the above characteristics.

Although the wetland boundaries and regulatory status of the wetland habitat on site were not established, an area supporting hydrophytes and containing saturated soils was observed in the southeastern portion of the site. Therefore, wetlands do exist at the Riverdale site.

In order to accurately define the area and provide a proper assessment, a formal identification and delineation of the wetland area is recommended.

Data regarding the levels of potential contaminants in the wetland area are extremely limited and in some cases nonexistent. This lack of information constitutes a critical data gap, preventing further evaluation of the impact of site contaminants on the wetlands and species that inhabit the area.

Barren Land

Barren land comprises approximately 6.25 acres, or 62.5% of the site. Barren land on site includes the parking lot, the entire northern portion of the site, much of the gravel covered southern portion of the site, the site buildings, the areas between the buildings, and the chemical staging area located in the western portion of the site. Most of the barren land on site consists of the site buildings and a thick layer of gravel, not covered with any vegetation.

Barren land areas are mostly devoid of habitat for ecological receptors. Few, if any, plants and animals inhabit these areas, although, a very few grasses have colonized the gravel covered areas.

The barren area is not considered to be of ecological importance or suitable habitat for wildlife species. It also is not considered to be an ecosystem of concern.

3.1.2.3 Species of Potential Concern

To identify species of potential concern in the site vicinity, current USFWS and Illinois Endangered Species Protection Board lists of threatened and endangered plants and animals in the vicinity were reviewed (see Appendix B).

USFWS (1999a) lists the American peregrine falcon (*Falco peregrinus anatum)* and Hine's emerald dragonfly (*Somatochlora hineana)* as the only federally endangered species existing in Cook County, Illinois. USFWS also lists the eastern prairie fringed orchid (*Platanthera leucophaea)* and prairie bush-clover (*Lespedeza leptostachya)* as federally threatened species existing in Cook County, Illinois. These species are discussed in detail below.

IDNR
Illinois Department of Natural Resources

An endangered species consultation was requested from the Illinois Department of Natural Resources (IDNR) for the area surrounding the Riverdale site; however, the consultation was not completed in time for this draft.

American Peregrine Falcon

USFWS (1999a) identifies the American Peregrine Falcon as a federally endangered species known to exist in Cook County, Illinois. The peregrin falcons inhabits open wetlands near cliffs. They prey mainly on ducks, shorebirds, and seabirds. Peregrine falcons occasionally are sighted in cities and on bridges and tall buildings (National Geographic Society 1987). Based on the disturbed nature of the site, and the lack of a large wetland, it is unlikely that the peregrine falcon exists in the site vicinity.

Hine's Emerald Dragonfly

USFWS (1999a) identifies the Hine's Emerald Dragonfly as a federally endangered species known to exist in Cook County, Illinois. This dragonfly can be found in small sites in Cook, DuPage, and Will counties in Illinois. The Hine's Emerald Dragonfly lives in calcareous marshes overlying dolomite bedrock (USFWS 1999b). Because the very specific habitat requirements for this species, and the lack of a marsh on site, it is highly unlikely that this dragonfly exists on site.

Eastern Prairie Fringed Orchid

USFWS (1999a) identifies the Eastern Prairie Fringed Orchid as a federally threatened species known to exist in Cook County, Illinois. The orchid occurs most often in mesic to wet unplowed tallgrass prairies and meadows. The Eastern Prairie Fringed Orchid also occurs in bogs, fens, and sedge meadows. This orchid depends on hawk moths for pollination (USFWS 1999c). Because of the lack of suitable habitat, it is highly unlikely that this species exists on site.

Prairie Bush-Clover

INC
Iowa Nature
Conservancy

USFWS (1999a) identified the Prairie Bush-Clover as a federally threatened species known to exist in Cook County, Illinois. Habitat requirements include well-drained dry to moderately moist (mesic) native prairies. Established populations occur in habitats that are located mainly on north facing, gentle slopes and fine silty loam, fine sandy loam, or clay loam substrates. The Riverdale site does not contain prairie habitat; therefore, this species is unlikely to occur on site (Iowa Nature Conservancy [INC] 1999).

3.1.2.4 Geology and Hydrogeology

The unconsolidated deposits at the site comprise glacially derived ground and end moraine deposits of the late Wisconsinan Age. In general, these moraines comprises of unsorted glacial tills containing boulders, sand, silt, and clay. The deposits at the site have been derived from a silty clay loam till material (Fehrenbacher et al. 1967).

A review of the well logs in the site area indicated that unconsolidated deposits attain a thickness of approximately 35 feet. Silurianage dolomitic limestone of the Niagara Formation underlies the unconsolidated deposits (IT 1997).

Investigations conducted on site by contractors for Riverdale revealed that the site is underlain by approximately 2 feet to 5 feet of fill material that directly overlies clay. The fill material consists of gravel, cinders, ash, and brick and wood fragments. In three of eight borings conducted on site by contractors, a relatively thin, discontinuous layer of brown sand to yellowish silty sand was encountered between the fill and the silty clay materials (IT 1997).

The RI Report (IT 1997) indicates that there are four aquifer systems in Cook County, Illinois, and that three of them are regionally extensive.

The sand and gravel aquifer is regionally extensive in the northwest portion of Cook County, and only locally present in buried bedrock valleys in other portions of the county. A shallow dolomite formation represents the first regionally extensive aquifer in the county. Where present, the sand and gravel aquifer is hydrologically connected with the shallow dolomite aquifers. Groundwater in the aquifer occurs in joints, fissures, and solution channels within the dolomite. The upper portion of the dolomite formation is generally the most productive for well development. Regionally, the groundwater flow in the shallow dolomite aquifer is to the southeast. However, because of the extensive pumpage of the groundwater for municipal and industrial use, local groundwater flow directions vary greatly (IT 1997).

3.1.2.5 Soils

According to the United States Department of Agriculture (USDA 1979) Soil Survey of DuPage and Cook Counties, Illinois, soils at the site and surrounding the site mainly comprise clayey Urban Land-Orthents complex.

Generally, this unit is comprised of less than 75% Urban land, with the remaining portion being Orthents, clayey. The Urban land is covered by buildings, parking lots, and pavements. The Orthents, clayey portion of the unit consists of fine textured soils that have been altered or mixed by cutting and filling. The soils formerly had a surface layer of silty loam to silty clay material with a subsoil of silty clay or clay materials. The underlying material is generally calcareous silty clay loam or silty clays (IT 1997).

Permeability is variable because the soil material has been altered, and compacted by construction equipment. Available water capacity is variable but generally low to moderate. Organic matter content and plant nutrients are low on new exposures, but developed areas usually are top-dressed where lawns and shrubs have been established (USDA 1979).

3.1.2.6 Topography

AMSL
above Mean Sea Level

The general topography of the site is very flat, with a slight slope in the eastern portion of the site to the southeast, toward the wetland area. In the western portion of the site, the site slopes toward the southwest. Elevations on site are approximately 660 feet above Mean Sea Level (AMSL). In the southern portion of the site along the drainage ditch, the site slopes down toward the ditch. The ditch is approximately 10 feet to 15 feet below the elevation of the Riverdale site.

3.1.2.7 Land Use

Land use on and adjacent to the site was identified by observations made by field personnel. Land-use types have been categorized according to *A Land Use and Land Cover Classification System for Use with Remote Sensor Data* (Anderson et. al. 1976). The following land-use types were identified within the vicinity of the site and are shown in Figure 3-3.

- Industrial and commercial complexes,
- Shrub and Brush Rangeland,
- Mixed urban or built-up land,
- Nonforested wetlands, and
- Transportation, Communications, and Utilities.

Industrial and Commercial Complexes

Industrial areas include many land uses, from light manufacturing plants to heavy manufacturing plants (Anderson et al. 1976).

Shrub and Brush Rangeland

Eastern brushlands are typically former crop lands or pasture lands, cleared from original forest land, which now have grown up in transition back to forest land to the extent that they are no longer identifiable as croplands or pasture lands. The western portion of the Riverdale site and the property adjacent to the site are old fields that have become overgrown with trees and brush.

Mixed Urban or Built-Up Land

The area adjacent to the north of the site is considered mixed urban or built-up. It is a mixture of residential land ranging from high- or low-density multiple unit structures, and industrial and commercial uses. The area across from the site along East 17^{th} Street is mixed urban or built-up land.

Nonforested Wetlands

Wetlands are those areas where the water is at, near, or above the land surface for a significant part of most years. The hydrological regime is such that aquatic or hydrophytic vegetation usually is established, although alluvial and tidal flats may be nonvegetated. Nonforested wetlands are dominated by wetland herbaceous vegetation or are nonvegetated. Examples of vegetation associated with nonforested wetlands are narrow-leafed emergents such as cattails (*Typha*), bulrush (*Scirpus*), sedges (*Carex*), and other grasses (Anderson et al. 1976).

Transportation, Communications, and Utilities

This land use category includes highways, railways, electric lines, and areas associated with these uses. Major transportation routes and areas greatly influence other land uses, and many land use boundaries are outlined by them. Highways and railways are characterized by areas of activity connected in linear patterns. Communications and utilities areas, such as those involved in processing, treatment, and transportation of water, gas, oil, and electricity and areas used for airwave communications, also are included in this category (Anderson et al. 1976).

3.1.2.8 Climate

The survey area is cold and snowy in winter and warm in summer. In the summer, temperatures average 72 °F. Precipitation is well-distributed during the year and generally adequate for most crops on most soils, but low available water capacity in some gravelly and sandy soils results in drought conditions for brief periods nearly every year.

From late fall through winter, snow squalls are frequent and total snowfall is normally heavy. In winter, the average temperature is 25°F.

Of the total annual precipitation, 22 inches, 67% usually falls from April to September. Average annual snowfall is 39 inches (USDA 1979).

3.1.2.9 Non-Site-Related Conditions of Potential Environmental Concern

This section describes conditions in the Riverdale site vicinity that are not related to the site, but may have or may have recently had and impact on the ecology and physical characteristics of the site.

Railroad

Rights-of-way for the Michigan Central, CHTT, and B&O railroads border the site to the south, east, and north. Runoff from the rail beds may enter the drainage ditch located on site along the southern border of the site. Herbicides similar to those formulated at the site may have been used along the railroad rights-of-way to control vegetation.

Steel Mill

A large steel mill is located south of the site just beyond the Michigan Central Railroad tracks. This facility is a manufacturing mill, and whether current or historical operations at the mill have impacted the Riverdale site is known.

3.1.2.10 Findings of Environmental Resources Survey and Inventory

Based on foregoing inventory, the environmental resources present at the Riverdale site can be summarized as follows:

- Land use in the site vicinity is dominated by industry and is likely to remain industrial.

- The terrestrial habitats of concern on the Riverdale site are limited in size and value;

- The wetland area located in the southeastern portion of the site is relatively small, less than 1 acre; however, it appears to serve as an important oasis for local wildlife and could serve as a stopover or even a nesting area for migratory waterfowl;

- The drainage ditch along the southern edge of the site is a low-quality habitat; however, it is capable of supporting aquatic and amphibian life as evidenced by the filamentous algae and small snail tracks observed in the ditch. The ditch is also a potential pathway by which materials from the southern edge of the site could migrate into the wetland area;

- There are not likely to be any federal or state species of potential concern on or in the immediate site vicinity; and

- The potential for migration of contaminants from operational areas of the facility to the wetland area and the drainage ditch along the southern edge of the site has not been adequately evaluated for contaminants of potential ecological concern (COPECs);

COPECs
contaminants of potential ecological concern

3.1.3 Ecological Risk Evaluation

3.1.3.1 Terrestrial Habitat

Substantial concentrations of a number persistent and bioaccumulative pesticides, including aldrin, dieldrin, DDD, DDE, DDT, chlordane, heptachlor and its epoxide, and toxaphene, and polychlorinated dioxins and furans have been found in soils at the Riverdale site. Many of these chemicals are known to be toxic to soil invertebrates, birds and mammals, however the ecological survey and inventory of the site found that the terrestrial habitat at the site was limited in size and value, and that federal and state species of concern were not likely to be present on or in the immediate vicinity of the site. In short, there are no valuable terrestrial environmental resources that are likely to be affected directly by soil contamination at the site. Therefore, potential impacts of site soil contaminants on terrestrial receptors were not evaluated.

3.1.3.2 Wetland Habitat

The ecological survey and inventory of the site documented the presence of a small wetland area in the southeastern part of the site and a drainage ditch along the southern edge of the site that is capable of supporting aquatic and amphibian life. While these areas are small in size, there is evidence that they are used by local wildlife and they could serve as a stopover or even a nesting area for migratory waterfowl. Based on these findings, these areas appear to be potentially valuable ecological resources.

Surface water and sediment from the wetland area and drainage ditch were not sampled during any of the field investigations carried by the U.S.EPA FIT or IT Corporation between 1984 and

1986 (IT 1997). Therefore, there are no data available on the presence or absence of contaminants in these areas. However, substantial concentrations of various pesticides and dioxins have been found in surface and subsurface soils in the active industrial part of the site north and west of the wetland and drainage ditch areas. Based on field observations and topographic maps of the site, surface water runoff from the northeastern, eastern, and southeastern portions of the site, flows to the south and southeast, towards and into the wetlands area (see Figure 3-1). Runoff from the Raw Materials Storage Pad Area also flows east or southeast into the wetlands area. Furthermore, a Site Utility Map included in the November 1999 draft Feasibility Study Report prepared by RMT, Inc. on behalf of Riverdale (RMT 1999, Figure 3) shows a storm sewer line that collects runoff from the eastern side of the Interior Tank Farm and appears to discharge just east of the wetlands area. Consideration of the surface water drainage patterns at the site indicates that potentially complete migration pathways exist by which contaminants could travel from areas where they are known to exist, to the wetland area and drainage ditch. Since most of the pesticide and dioxin contaminants found in the site soil are nearly insoluble, migration would occur mainly through association with soil particles entrained in the surface runoff.

A number of the pesticides and dioxins found at substantial concentrations in site soil are persistent and bioaccumulative and are known to be toxic to aquatic organisms, birds and mammals.

- DDT and its breakdown products, DDE and DDD, are highly toxic to many aquatic invertebrates species and fish species as well (Johnson and Finbley 1980). DDT may be moderately toxic to some amphibian species and larval stages are probably more susceptible than adults. In addition to acute toxic effects, DDT may bioaccumulate significantly in fish and other aquatic species, leading to long-term exposure. DDE is an endocrine disruptor that has been shown to interfere with bird reproduction by thinning eggshells.

- Aldrin and dieldrin are highly toxic to aquatic life. They also accumulate in the tissues of aquatic organisms resulting in acute toxic effects in birds and mammals feeding on those organisms.

- Chlordane is highly toxic to freshwater invertebrates and fish. It also bioaccumulates in bacteria and in marine and freshwater fish species.

- Heptachlor and the epoxide are very highly toxic to most fish species. Heptachlor is also very highly toxic to freshwater aquatic invertebrates. Both heptachlor and heptachlor epoxide have been shown to bioconcentrate in aquatic organisms such as fish, mollusks, insects, plankton, and algae.

- Information on the toxicity of TCDD to ecological receptors is sparse. However, the data that are available show that fish are generally more sensitive to TCDD than aquatic plants, aquatic invertebrates, and other aquatic vertebrates such as amphibians.

Because there is a significant possibility that contaminants found elsewhere at the site may have migrated to the wetland area and drainage ditch, and because of the serious adverse effects they could have on ecological resources if they are present in these areas, it is important that the presence or absence of contamination in these be determined. Surface water and sediment in the wetland and the drainage ditch, and surface soil in potential migration pathways leading from contaminated areas of the site to these areas should be sampled and analyzed for the contaminants found in other areas of the site. An ecological risk evaluation of the wetland area and drainage ditch should then be completed once any contamination in these areas has been adequately characterized.

3.1.4 Conclusions

Based on the inventory of environmental resources and the information presented regarding COPECs, the following conclusions regarding the overall risk associated with the Riverdale site were made:

1. Potentially valuable ecological resources have been identified on or near the site. The must notable are the wetland area in the southeastern corner of the site and the drainage ditch along the southern edge of the site;

2. Based on the concentrations of COPECs detected in site surface soils, most notably TCDD, there is potential for adverse effects associated with COPECs in these soils.

3. Additional sampling of soil, sediment, and surface water in and near the wetland area and drainage ditch is needed to characterize contamination in these areas and to evaluate potential impact on environmental receptors; and

4. Additional samples also should be collected from nearby background locations to adequately evaluate the area surrounding the site.

3.2 Human Health Evaluation

This section describes the general approach used to evaluate the potential health risks for the areas of concern identified at the Riverdale site. In accordance with U.S. EPA *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (U.S. EPA 1993a), a quantitative evaluation was performed only for the exposure pathways and receptors that were identified as potentially complete.

Since the site is currently used for industrial purposes and is expected to continue in that use, the main purpose of this EE/CA is to determine what removal actions may be needed in order to protect the health and safety of current and potential future workers at the site. Accordingly, the human health portion of the SRE will focus on the potential risks to current and future site workers.

SHHRE
streamlined human health risk evaluation

COPCs
chemicals of potential concern

The site is underlain by at least 15 feet of low permeability clay, therefore groundwater is not expected to be impacted by site contaminants. Furthermore, groundwater in the vicinity of the site is not presently used, nor is it expected to be used in the future because the site is served by a public water supply system. Therefore, the streamlined human health risk evaluation (SHHRE) will focus on soil exposure pathways; groundwater pathways will not be addressed.

The human health assessment is organized in accordance with the general approach outlined in RAGS Volume I, Parts A (U.S. EPA 1989a) and D (U.S. EPA 1998b), and uses the Standard Tables specified in Part D. The numbering of the Standard Tables is specified in the guidance and does not always correspond to the order in which the tables are cited in this document. Section 3.2.1 reviews the data evaluation and selection of chemicals of potential concern (COPCs). Section 3.2.2 assesses potential exposure of receptors to the COPCs. Section 3.2.3 provides toxicity assessments for the COPCs at the site. Section 3.2.4 integrates the exposure and toxicity assessments from previous sections into an overall risk assessment. A discussion of sources of uncertainties associated with the risk assessment is presented in Section 3.2.5.

3.2.1 Data Evaluation and Selection of Chemicals of Potential Concern

3.2.1.1 Evaluation of Data for Use in the Screening Risk Evaluation

EPCs
exposure point concentrations

SQL
sample quantitation limit

STV
Screening Toxicity Value

RBC
Risk-Based Concentration

HI
hazard index

The first step of the data review consisted of a review of data qualifiers to determine data usability for the SRE. Several types of qualifiers are associated with many of the values reported and validated through the data evaluation process. Rejected (R-qualified) data were not used, but estimated (J-qualified for organics, B-qualified for metals) data were used to estimate exposure point concentrations (EPCs) as recommended by U.S. EPA (1992a). If a chemical was not detected in a sample (U-qualified values), a value of one-half of the sample quantitation limit (SQL) for the sample was used in calculating EPCs, unless that value was greater than the maximum concentration of the chemical actually detected in any sample of that medium, in which case the sample was not used in calculating EPCs. SQLs were not available for the IT data, so one-half of the U-qualified value was used in place of the U-qualified value for these data. Organic chemicals detected at concentrations 10 times or less (for common laboratory chemicals) or five times or less (for all other substances) than the maximum concentration reported in the associated method or field blank were considered artifacts of sampling and analysis methodology, and were treated as not detected. A review of data qualifiers and reports indicated that the quality of the data collected for the Riverdale site was adequate for use in the SRE.

SQLs for chemicals that were not detected were evaluated by comparison to screening toxicity values (STVs). The STVs were derived from U.S. EPA, Region 3's Risk-Based Concentration Table (RBC) (U.S. EPA 1999a). The STVs used for comparison were based on a target excess cancer risk of 1×10^{-6} or a noncancer hazard index (HI) of 0.1, for a residential receptor. A residential receptor was evaluated as a conservative (i.e., health-protective) reference point. If the nominal sample detection limit was at or below the STV, then it was considered adequate for use in the SRE. The ranges of nondetected concentrations (i.e., SQLs or detection limits) in the evaluated data are included in Appendix C, Table 2.1. All of the soil SQLs for the Riverdale Chemical Company site data were below the STVs corresponding to a cancer risk of 1×10^{-6} or a noncancer HQ of 0.1, and are acceptable for use in the SRE.

RBSLs
risk-based screening levels

3.2.1.2 Identification of Chemicals of Potential Concern

COPCs for human health effects at the site were identified by comparing detected concentrations to U.S. EPA Region 3 risk-based screening levels (RBSLs) for soil for industrial workers (U.S. EPA 1999a). The U.S. EPA Region 3 RBSLs use a target cancer risk of 1×10^{-6}, or a target HI for noncancer effects of 0.1, whichever is lower. These comparisons, and the rationale for selecting or excluding a chemical as a COPC, also are shown in Appendix C, Table 2.1.

3.2.1.3 Conceptual Site Model

Because the site is used for industrial purposes and is expected to continue to be used in that way, the human population potentially exposed to site contaminants is expected to be the same in the present and future. The population most likely to be exposed comprises workers employed full time at the site. Construction and/or utility workers coming in contact with the soil during construction, installation, or maintenance activities at the site are a second population likely to be exposed to site contaminants. Visitors or trespassers, who enter the site occasionally, also might be exposed to site contaminants; however, because the site is fenced, locked, and/or guarded on the sides closest to the adjacent residential area, potential exposure of these individuals is expected to be minimal.

Regular site workers and construction/utility workers could be exposed to soil contaminants through dermal contact with, and incidental ingestion of soil as a result of direct contact with the soil. Exposure also might occur through inhalation of contaminant vapors or contaminated particles released from the soil. Current regular site workers would be exposed only to contaminants in surface soil. Construction/utility workers and future regular site workers could be exposed to contaminants in surface and subsurface soil: construction/utility workers through direct contact with both surface and subsurface soil, and future regular site workers through contact with existing surface soil and current subsurface soil brought to the surface as a result of construction or maintenance activities. Potentially complete exposure routes and receptors are shown schematically in Figure 3-4 and are summarized in Appendix C, Table 3.1.

3.2.2 Exposure Assessment

3.2.2.1 Exposure Point Calculations

The exposure media of concern for this SHHRE are surface and near-surface soils.

UCL
upper confidence limit

Derivation of Exposure Point Concentrations for Soil

Over time, individuals generally are assumed to have an equal chance of contacting potentially contaminated soil anywhere within an exposure area. Therefore, the arithmetic average soil concentration of each COPC in an exposure area provides the best estimate of the potential long-term exposure an individual might experience in that area. The 95% upper confidence limit (UCL) on the average concentration provides a conservative estimate of the average concentration and is used as the EPC for each COPC.

EPCs were estimated directly from measured concentrations. The data sets were evaluated to determine whether the concentrations best fit a normal or lognormal distribution. The UCLs of the average chemical concentrations in the sample set then were calculated using the equation appropriate for the distribution of the sample set. If a calculated UCL exceeded the maximum measured concentration detected in the sample set, then the maximum detected concentration was used as the EPC. One-half of the SQL was used in the calculation of EPCs when a chemical was not detected in a sample, unless that value was greater than the maximum detected value for that chemical, in which case the sample was not used.

This SHHRE evaluates risks associated with baseline conditions at the site. These are the conditions that currently exist or are expected to exist at the site in the absence of any remedial measures. A few samples, SS15, SS30, SS31, and SS32, collected from 1984 to 1986, were from an area of the site that is now occupied by Building No. 1, the Finished Goods Warehouse. The concrete floor of the building, which is considered a permanent site feature, has rendered the soil represented by these samples inaccessible, therefore these samples were excluded from EPC estimates. Many additional soil samples were from areas covered by a layer of crushed limestone that was originally placed, and has been maintained, as an IRM to prevent direct contact with contaminated soil. Because the crushed limestone is an IRM, which is inherently temporary in nature, it is not considered to be part of the baseline site conditions. Therefore, for the purpose of this baseline SHHRE, soil covered by the crushed limestone is considered accessible, or potentially accessible, to site workers.

Only surface soil is accessible to regular site workers (industrial workers) under existing site conditions; therefore, EPCs for regular site workers were derived from the uppermost soil samples collected from each location (generally samples beginning at the ground surface). Construction and/or utility workers who engage in invasive activities could come in contact with surface and subsurface soils; therefore, EPCs for these workers were derived from all soil samples except those now covered by Building No. 1.

The EPCs determined for potential exposure media at the Riverdale site are presented in Appendix C, Tables 3.1 and 3.2.

3.2.2.2 Exposure Estimation Methods

The exposure estimates described in this section combine the following:

- Estimates of EPCs developed in the previous section;
- Estimates of contact rate, and frequency and duration of exposure that receptor populations are likely to experience; and
- Estimates of various physiological parameters (e.g., body weight and average life expectancy).

RME
reasonable maximum exposure

The equations used to estimate the exposure for each scenario, exposure pathway, exposure point, and receptor population evaluated in this SRE are presented in Appendix C, Tables 4.1 and 4.2. The parameter values used in the equations and their sources also are provided. Parameter values generally were based on information and recommendations in U.S. EPA guidance documents, when available, and were selected to correspond to the reasonable maximum exposure (RME) that an individual in the receptor group might experience.

- **Potential Receptors and Exposure Pathways**

  Regular Site Industrial Workers

  Regular site industrial workers are assumed to be adults who spend much of their time outdoors managing various materials or engaged in other outdoor activities. These individuals may be exposed to site contaminants through dermal contact with, and incidental ingestion, of contaminated soils. These individuals also might inhale contaminated soil particles that have become airborne as a result of wind erosion or vehicular traffic; however, the risk assessment included in the RI Report (IT 1997) indicates that exposure via this pathway is thousands of times less than that via the other pathways; therefore, it was not quantitatively evaluated in this SHHRE.

Construction and Utility Workers

Construction and utility workers are workers who are assumed to engage in soil excavation or grading work, or subsurface activities such as installation or maintenance of footings, foundations, or utility lines. These activities would bring those workers into close contact with surface and subsurface soil. Potential exposure pathways would be the same as those for regular site workers.

- **Exposure Factor Values**

Ingestion Rate of Soil

IR-S
soil ingestion rate

mg/day
milligrams per day

EFH
Exposure Factors Handbook

FS
Fraction from the source

EF
exposure frequency

ED
exposure duration

kg
kilograms

The soil ingestion rate (IR-S) is the amount of soil a person might ingest accidentally through hand-to-mouth contact. A value of 50 milligrams per day (mg/day) was used for industrial workers based on the recommendation of the Exposure Factors Handbook (EFH; U.S. EPA 1997a). A value of 100 mg/day, the largest value found in a tracer study reported by Calabrese et al. (1990), was used for construction workers.

Fraction from Source

Because the soil ingestion rates used are for industrial and construction workers, all of the soil incidentally ingested each day was assumed to be from the site, which corresponds to a fraction from the source (FS) of 1.0.

Exposure Frequency

The exposure frequency (EF) is based on U.S. EPA's standard default worker exposure frequency of 250 days per year (days/year; five days per week [days/week] for 50 weeks of the year) (U.S. EPA 1991a).

Exposure Duration

The exposure duration (ED) should reflect the length of time workers are likely to work at the site. Therefore, the ED for permanent site workers (industrial workers) was set to 21.9 years, which is the median occupational tenure for workers 70 years of age and older who have substantially completed their working careers (U.S. EPA 1997b). Construction workers were assumed to work at the site for one year.

Body Weight

The average adult body weight of 71.8 kilograms (kg) recommended by the EFH (U.S. EPA 1997a) was used.

SA
skin area

SSAF
soil-to-skin adherence factor

DABS
dermal absorption factor

CDIs
chronic daily intakes

LADIs
lifetime average daily intakes

Averaging Time

The averaging time selected dependents on the type of toxic effect evaluated. For noncarcinogenic effects (AT-N) is equal to the ED. For carcinogenic effects (AT-C), the exposure is averaged over an expected lifetime of 75 years (U.S. EPA 1997a).

Skin Area

The skin area (SA) is the area of skin that comes in contact with soil. Soil-to-skin adherence data are generally available only for entire body regions (e.g., arms, legs, hands, and feet); therefore, the EFH recommends that skin areas for entire regions be used, although only a portion of a region actually might be exposed to contact with soil (e.g., lower arms or legs). Skin area is proportional to body weight; therefore, the average area of the arms, hands, legs, and face (one-half of the head) for men and women (U.S. EPA 1997a, Tables 6-4 and 6-5) was used.

Soil-to-Skin Adherence Factor

The soil-to-skin adherence factor (SSAF) was derived from data presented in Table 6-12 of the EFH (U.S. EPA 1997a), as recommended in Section 6.4.2 of that document. The area-weighted average of the geometric mean values for utility workers and equipment operators was used for industrial and construction/utility workers.

Dermal Absorption Factor

The dermal absorption factor (DABS) is the fraction of the amount of a chemical in the soil that is absorbed by the skin and is specific to each chemical. The values used and their sources are presented in Appendix C, Table 4.3.

3.2.2.3 Exposure Estimates

The exposure estimates derived using the input parameters described above are presented as chronic daily intakes (CDIs) for noncancer effects, and as lifetime average daily intakes (LADIs) for carcinogenic effects for each exposure case. Exposure estimates are presented in Appendix C; those for noncarcinogenic effects are included in Tables 7.1 and 7.2, while those for carcinogenic effects are included in Tables 8.1 and 8.2.

The exposure estimates are combined with toxicity estimates for the COPCs, discussed in Section 3.2.3, to obtain risk estimates, which are discussed in Section 3.2.4.

3.2.3 Toxicity Assessment

The purpose of the toxicity assessment is to review toxicity and carcinogenicity data for the COPCs, and to provide an estimate of the relationship between the extent of exposure to these contaminants and the likelihood and/or severity of adverse effects. The toxicity assessment is accomplished in two steps: hazard identification and dose-response assessment.

The hazard identification is a qualitative description of the potential toxic effects of COPCs. The toxicological profiles presented in Appendix D describe the toxic effects that have been observed in humans and/or animals following exposure to the COPCs identified at the Riverdale site. In most cases, the information in the summaries has been drawn from the Public Health Statement in the ATSDR's toxicological profile and/or from the U.S. EPA health assessment document for the chemical (ATSDR 1998; ATSDR 1994a; ATSDR 1994b; ATSDR 1993a; ATSDR 1993b). For carcinogens, the weight-of-evidence category also is included. The U.S. EPA weight-of-evidence categories are as follows:

EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY

Group		Description
A		Human carcinogen.
B		Probable human carcinogen:
	B1:	Indicates that limited human data are available.
	B2:	Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C		Possible human carcinogen.
D		Not classifiable.
E		No evidence of carcinogenicity for humans.

U.S. EPA 1989a.

SF
slope factor

RfD
reference dose

The dose-response assessment is a process that results in a quantitative estimate or index of toxicity for each COPC at a site. For carcinogenic effects, the index is the slope factor (SF), and for noncarcinogenic effects, it is the reference dose (RfD). Practices and procedures used to develop quantitative indices of toxicity and to incorporate toxicological information into the risk estimation process, and the quantitative indices of toxicity themselves, are presented in Section 3.2.3.1.

3.2.3.1 Development of Toxicity Values

Carcinogenic and noncarcinogenic health effects were evaluated quantitatively in the risk evaluation. Endpoints for these two different types of effects were assessed differently because the mechanism(s) by which chemicals cause cancer is fundamentally different from the process(es) by which noncarcinogenic effects are caused. The principal difference in the evaluation reflects the assumption that noncarcinogenic effects exhibit a threshold dose below which no adverse effects occur, whereas no such threshold has been shown to exist for most carcinogenic effects.

Classification of Chemicals as Carcinogens or Noncarcinogens

As used in this risk evaluation, the term *carcinogen* refers to a chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or animals. Conversely, the term *noncarcinogen* refers to any chemical for which the carcinogenic evidence is negative or insufficient.

The likelihood that a chemical is a human carcinogen is specified by U.S. EPA's weight-of-evidence classification. Data derived from human and animal studies are reviewed and characterized as sufficient, limited, no data, or evidence of no effect. According to these U.S. EPA guidelines, chemicals in the first two groups, A and B (B1 or B2), are considered human carcinogens or probable human carcinogens and should be subjected to nonthreshold carcinogenic risk procedures. Group C chemicals, which are considered to be possible human carcinogens, may or may not be subject to these procedures, depending on the quality of the available data. Group D chemicals are not classifiable as carcinogens or noncarcinogens because of inadequate evidence, while Group E chemicals show no evidence of carcinogenicity in human or animal studies.

Exposure to some chemicals may result in carcinogenic and noncarcinogenic effects. For those cases, both types of effects were considered and evaluated in the quantitative assessment.

NOAEL
no-observed-adverse-effect level

LOAEL
lowest-observed-adverse-effect level

UFs
uncertainty factors

mg/kg-day
milligrams per kilogram per day

Assessment of Noncarcinogens

The potential for noncarcinogenic adverse health effects (e.g., organ damage, immunological effects, birth defects, and skin irritation) usually is assessed by comparing the estimated site-related exposure to the RfD). U.S. EPA develops the RfD by identifying the no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) in the scientific literature and adjusting that value using uncertainty factors (UFs), which compensate for the data limitations of the critical study or studies and for the uncertainties associated with differences between the study conditions and the human exposure situation (e.g., different species, different doses, different routes, and different lengths of exposure) and variability in the human population, so that the resulting RfD is protective of the human population. RfDs are expressed in units of milligrams per kilogram per day (mg/kg-day).

According to U.S. EPA (1997c), the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is used as a reference point for gauging the potential effects of other exposures. Generally, exposures that are less than the RfD are not likely to be associated with adverse health effects. As the exposure increases beyond the RfD and as the size of the excess increases, the potential for health effects also increases. Noncarcinogenic hazards are usually assessed by calculating a HQ for each chemical exposure by each exposure pathway as follows:

$$HQ = CDI/RfD$$

where:

HQ = Hazard quotient,
CDI = Chronic daily intake, and
RfD = Reference dose.

HQs associated with the same type of adverse health effect should be summed across pathways and chemicals to obtain a hazard index (HI). An HI greater than 1 indicates that adverse effects are possible, whereas an HI less than 1 indicates that adverse effects would not be expected. The higher the HI is above 1, the more likely it is that an adverse effect could occur.

Assessment of Carcinogens

In contrast to noncarcinogenic effects for which thresholds are thought to exist, thresholds have not been demonstrated for most carcinogenic effects. Consequently, federal regulatory agencies assume that any exposure to a carcinogen entails some finite risk of cancer. However, depending on the potency of a specific carcinogen and the level of exposure, such a risk could be extremely small.

Several mathematical models have been developed to estimate low-dose carcinogenic risks from high-dose cancer bioassays. U.S. EPA (1986) has selected the linearized multistage model to estimate toxicity values based on prudent public health policy and uses the 95% UCL of the slope of the dose-response curve to estimate low-dose SFs. The results of this procedure are unlikely to underestimate the actual SFs (formerly termed carcinogenic potency factors) for humans. SFs are expressed as the inverse of the daily dose per unit body weight ($[mg/kg\text{-}day]^{-1}$).

Using SFs, excess lifetime cancer risks associated with each chemical exposure by each pathway can be estimated by:

$$Risk = LADI \times SF$$

where:

LADI = Lifetime average daily intake, and
SF = Slope factor.

The separate cancer risks are summed across chemicals and exposure pathways that apply to a given receptor group to obtain the total cancer risk for that receptor.

Route-to-Route Extrapolation of Reference Doses and Slope Factors

Because U.S. EPA has not developed RfDs and SFs for the dermal route, oral RfDs and SFs are commonly used to evaluate risks from dermal exposure. When this is done, the oral toxicity value, which is based on the administered dose, must first be adjusted to an absorbed dose basis because dermal exposures are expressed as absorbed doses. The dermal SF is estimated by dividing the oral SF by the fraction of the administered dose that is absorbed

GI
Gastrointestinal

IRIS
Integrated Risk
Information System

HEAST
Health Effects
Assessment Summary
Tables

NCEA
National Center for
Environmental
Assessment

through the gastrointestinal (GI) tract. The dermal RfD is estimated by multiplying the oral RfD by the fraction of GI absorption.

Extrapolation of toxicity values from one route to another is inappropriate and is not done if the critical effect for either route is at the point of contact. For example, ingestion of benzo(a)pyrene and other carcinogenic PAHs causes stomach cancer, whereas dermal exposure causes skin cancer; therefore, the oral SFs that are used to estimate cancer risks from oral exposures should not be used to estimate cancer risks from dermal exposures.

3.2.3.2 Toxicity Values for the COPCs at the Riverdale Chemical Company Site

Toxicity values for carcinogenic and noncarcinogenic effects were compiled from the following U.S. EPA sources:

- The Integrated Risk Information System (IRIS) computer database (U.S. EPA 2000). This is the preferred source of toxicity values because these data are the most recent U.S. EPA criteria available and they have been reviewed extensively by U.S. EPA;

- Health Effects Assessment Summary Tables (HEAST; U.S. EPA 1997c). HEAST was consulted if a toxicity value was unavailable on IRIS. U.S. EPA's National Center for Environmental Assessment (NCEA) established these provisional values for use in risk evaluations; and

- NCEA's Superfund Health Risk Technical Support Center, which provides provisional RfDs and SFs for some chemicals that are not listed in IRIS or HEAST.

Only values that are currently available from the above sources were used in this risk evaluation. Pending or withdrawn values were not used.

In Appendix C, Tables 5.1 and 6.1 present the oral and dermal toxicity values that were used in this risk evaluation. Table 5.1 lists the oral and dermal RfDs for noncarcinogenic effects along with the oral-to-dermal adjustment factor, the associated target organ(s), the confidence level, and the source of the oral RfD. Table 6.1 lists oral and dermal SFs along with the oral-to-dermal adjustment factor, U.S. EPA's weight-of-evidence classification, and the source of the oral SF.

3.2.4 Risk Characterization
This section combines the information developed in the exposure and toxicity assessment sections to obtain estimates of the risks posed to human health by exposure to COPCs at the Riverdale site.

The potential excess cancer risk and chronic hazard quotients were estimated for reasonable maximum exposures for permanent site workers (industrial workers) and construction/utility workers. Section 3.2.4.1 presents the risk estimates. Section 3.2.4.2 summarizes the risk estimation results and identifies the COPCs and pathway(s) that account for the most significant risks at the Riverdale site. Uncertainties associated with the risk estimates are discussed in Section 3.2.5.

3.2.4.1 Risk Estimates
Carcinogenic Risk Estimation

Potential carcinogenic risk is assessed by multiplying the estimated LADI of a carcinogen by its estimated SF to obtain the estimated risk, expressed as a probability of that exposure resulting in an excess incidence of cancer (i.e., more cancers than normally would be expected in that population). The excess cancer risk for exposure to each chemical by each route of exposure, category of receptor, and exposure case initially is estimated separately. The risk estimates then are summed across chemicals and across all exposure routes and pathways applicable to the same population to obtain a total cancer risk for that population.

Current U.S. EPA Superfund policy, as stated in the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP U.S. EPA 1992d), is that acceptable exposures to known or suspected carcinogens are generally those that represent an excess upper-bound lifetime cancer risk to an individual from 10^{-4} to 10^{-6}.

Noncarcinogenic Risk Estimation

The potential for adverse effects resulting from exposure to systemic toxicants (noncarcinogens) is assessed by comparing the estimated CDI of a substance to its chronic RfD. This comparison is performed by calculating the ratio of the CDI to its corresponding RfD, which is the HQ. HQs should be summed across chemicals that produce the same type of adverse effects (e.g., liver damage), but should be kept separate if their critical effects are different. However, for screening purposes, HQs are commonly summed across all chemicals, exposure routes, and pathways applicable to a given population to obtain an HI for that population.

For noncarcinogens, U.S. EPA (1992d) defines acceptable exposure levels as those to which the human population, including sensitive subpopulations, may be exposed without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety. This acceptable exposure level corresponds approximately to an HI of 1. If the HI is less than 1, adverse effects usually would not be expected. As the HI increases beyond 1, the possibility of adverse effects occurring also increases.

Risk Estimates

Carcinogenic Risk Estimation

Detailed estimates of the potential risks to regular site workers (industrial workers) and construction/utility workers are provided in Appendix C, Tables 7.1, 7.2, 8.1, and 8.2. Summaries of the estimated risks are provided in Tables 9.1, 9.2, 10.1, and 10.2. An overall risk evaluation summary is provided in Table 3-5. For regular site workers, the estimated cancer risk is 2.2×10^{-2} and the estimated noncancer HI is 39.7. For construction/utility workers, the estimated cancer risk is 4.6×10^{-4} and the estimated noncancer HI is 51.5. More than 90% of the cancer and noncancer risks are due to aldrin, dieldrin, and 2,3,7,8-TCDD (dioxin).

Nature of Potential Adverse Health Effects

aldrin
dieldrin
dioxin
heptachlor

Significant cancer and noncancer risks are associated with exposure to site soil. Chemicals that contributed significantly to cancer and noncancer risks included, aldrin, dieldrin, dioxin and heptachlor. Aldrin, dieldrin, and heptachlor are suspected of causing liver cancer and adverse noncarcinogenic effects in the liver. Dioxin, which also contributed significantly to the estimated cancer risk, is suspected of causing cancer of the respiratory tract (U.S. EPA 2000).

Major Factors Driving Risks

The major factors driving the risks at the site are the presence of pesticides and dioxin in site soil coupled with potential for site workers to come in contact with the contaminated soil.

3.2.5 Discussion of Uncertainty

In order to evaluate the meaning of a risk assessment, uncertainties in the assumptions made, the potential impact of quantitative changes in those assumptions on the risk estimates, and the relevance of the findings to the real world exposures and risks must be considered. Because of the number of assumptions, data points, and calculations, a degree of uncertainty necessarily is associated with the exposure values and numerical toxicity values used in any risk assessment. The following sections discuss the uncertainties associated with the exposure and toxicity assessments, and with the resultant risk characterization calculations.

3.2.5.1 Uncertainties Related to the Exposure Assessment

Environmental Sampling and Analysis

Samples collected during the investigations were intended to characterize the nature and extent of soil contamination. Accordingly, sampling locations were selected in a purposeful or directed manner to accomplish that goal. Samples collected in this manner provided considerable information about the site and, in this case, are probably reasonably representative of contamination that may be present on the site as a whole. However, because they were not collected from randomly selected locations, the samples are not statistically representative.

QC
quality control

Because of the variability and uncertainty inherent in the sampling and measurement processes, the reported chemical concentrations may differ from the actual chemical concentrations. Additional uncertainty is introduced by the use of estimated results, which may not have the same precision and accuracy as data meeting all standard quality control (QC) criteria, as well as by the use of nondetect results, assuming a concentration of one-half the reported detection limit, which may overestimate or underestimate the true concentrations present. These factors decrease the level of confidence in the exposure concentration estimates but are generally minor contributors to the overall risk characterization uncertainties.

Exposure Pathways

Potential resuspension and inhalation of contaminated soil particles were not evaluated quantitatively in the SRE because the risk assessment included in the RI Report for the site found that this pathway contributed very little to site-related risks.

Exposure Point Concentrations

The maximum detected concentrations of many of the COPCs were used as the EPCs for site soils. This was done in accordance with U.S. EPA (1992e) guidance on determining EPCs because the 95% UCL for these data sets exceeded the maximum detected concentrations. The use of maximum detected EPCs increases the likelihood that the risks from these chemicals are overestimated. Because risk estimates helped to drive the risk estimates for the site, the overall site risks also may be somewhat overestimated.

Exposure Estimation Calculations

The primary uncertainty regarding the exposure estimation calculations is associated with the selection of appropriate parameter values. Individual parameter values were selected so that the overall pathway exposure estimates would approximate high-end (reasonable maximum) exposures, thereby overestimating, rather than underestimating, the typical risks for the potentially exposed population. The sources of the exposure factor values used are discussed in Section 3.2.2.2.

3.2.5.2 Toxicity Assessment Uncertainties

The basic uncertainties associated with the derivation of toxicity values in the toxicity assessment include:

- Uncertainties arising from the design, execution, or relevance of the scientific studies that form the basis of the assessment; and

- Uncertainties involved in extrapolation from the underlying scientific studies to the exposure situation being evaluated, including variable responses to chemical exposure within human and animal populations, between species, and between routes of exposure.

These uncertainties could result in a toxicity estimate based directly on the underlying studies that either underestimate or overestimate the true toxicity of a chemical. The toxicity assessment process compensates for these basic uncertainties through the use of UFs and modifying factors in the derivation of RfDs for assessing noncarcinogenic effects, and the method of calculating the 95% UCL value from the linearized multistage model to derive low-dose SFs for assessing cancer risks. This approach ensures that the potential toxicity of a chemical to humans is unlikely to be underestimated; however, actual toxicity may be overestimated substantially as a result.

The use of adjusted oral toxicity values to evaluate dermal risks is an additional source of uncertainty to the dermal risk estimates, because the biokinetics (uptake, distribution, metabolism, and elimination) from dermal exposure may be different from ingestion. Because of the differences, effects caused by oral exposure to a chemical may not be caused by dermal exposure, or they may occur at a higher or lower dose.

In the absence of information to the contrary, U.S. EPA guidelines indicate that carcinogenic risks should be treated as additive and that HIs for similar noncarcinogenic effects should also be treated as additive. The assumption of risk additivity ignores possible synergisms or antagonisms among different chemicals, which would increase or decrease the chemicals' toxic effects and could tend to underestimate or overestimate total site risks.

3.2.5.3 Risk Characterization Uncertainties

As explained previously, intentionally conservative assumptions are used throughout the risk evaluation process so that the true risk is unlikely to be underestimated. The cumulative effect of this approach could be to substantially overestimate the true risk.

The last uncertainty to consider is the probability of the postulated exposures actually occurring. The soil exposure pathways potentially would be complete if the site were redeveloped without prior soil remediation or coverage of the soils to prevent exposure. The postulated exposure rates and frequencies of occurrence may overestimate the average exposures, but certainly could reflect the RME for the site visitor scenario evaluated.

Table 3-1

VEGETATION OBSERVED AT THE RIVERDALE CHEMICAL COMPANY SITE RIVERDALE CHEMICAL COMPANY CHICAGO HEIGHTS, ILLINOIS

Common Name	Scientific Name	Habitat
Eastern Cottonwood	*Populus deltoides*	Perennial herbaceous-woody
Red Maple	*Acer rubrum*	Perennial herbaceous-woody and wetland
Red Mullberry	*Morus rubra*	Perennial herbaceous-woody
Ash	*Fraxinus spp.*	Perennial herbaceous-woody
Honey Locust	*Gleditsia triacanthos*	Perennial herbaceous-woody
Black Cherry	*Prunus serotina*	Perennial herbaceous-woody
Wild Rose	*Rosa spp.*	Perennial herbaceous-woody
Black Raspberry	*Rubus allegheniensis*	Perennial herbaceous-woody
Grassess	*Gramineae spp.*	Perennial herbaceous and woody
Sedges	*Cyperaceae spp.*	Perennial herbaceous and wetland
Common Dandelion	*Taraxacum officinale*	Perennial herbaceous
Golden rod	*Solidago spp.*	Perennial herbaceous
Aster	*Aster spp.*	Perennial herbaceous
Tick-Trefoils	*Desmodium spp.*	Perennial herbaceous
Common Strawberry	*Fragiaria virginiana*	Perennial herbaceous
Queen Anne's Lace	*Daucus carota*	Perennial herbaceous
Bull Thistle	*Cirsium vulgare*	Perennial herbaceous
Milk weed	*Asclepias spp.*	Perennial herbaceous
Cattails	*Typha spp.*	Wetland
Ragweed	*Ambrosia artemisiifolia*	Perennial herbaceous
Reed Grass	*Phragmites communis*	Wetland
Water-Flaxseed	*Spirodela polyrhiza*	Wetland

Table 3-2

REPTILES AND AMPHIBIANS POTENTIALLY EXISTING AT THE RIVERDALE CHEMICAL COMPANY SITE CHICAGO HEIGHTS, ILLINOIS

Common Name	Scientific Name
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*
Racer	*Coluber constrictor*
Rat Snake	*Elaphe obsoleta*
Milk Snake	*Lampropeltis triangulum*
Eastern Hognose Snake	*Heterodon platyrhinos*
Brown Snake	*Storeria dekayi*
Eastern Ribbon Snake	*Thamnophis sauritus*
Spotted Salamander	*Ambystoma maculatum*
Tiger Salamander	*Ambystoma tigrinum*
Eastern Newt	*Notophthalmus*
American Toad	*Bufo Americanus*
Spring Peeper	*Hyla crucifer*
Green Frog	*Rana clamitans*
Bullfrog	*Rana catesbeiana*
Pickerel Frog	*Rana palustris*
Northern Leopard Frog	*Rana pipens*
Eastern Box Turtle	*Terrapene carolina*
Snapping Turtle	*Chelydra serpentina*

Source: Ecology and Environment, Inc. 2000.

Table 3-3

BIRDS OBSERVED OR POTENTIALLY EXISTING AT THE RIVERDALE CHEMICAL COMPANY SITE CHICAGO HEIGHTS, ILLINOIS

Common Name	Scientific Name	Season	Observed
Rock Dove	*Columba livia*	Y	Yes
Purple Finch	*Carpodacus purpureus*	S	Yes
House Finch	*Carpodacus mexicanus*	Y	Yes
Mourning Doves	*Zenaida macroura*	Y	Yes
American Goldfinch	*Carduelis tristis*	Y	Yes
Field Sparrow	*Spizella pusilla*	Y	Yes
House Sparrow	*Passer domesticus*	Y	Yes
European Starling	*Sturnus vulgaris*	Y	Yes
Common Grackle	*Quiscalus quiscula*	Y	Yes
American Crow	*Corus brachyrhynchos*	Y	Yes
Northern Cardinal	*Cardinalis cardinalis*	Y	No
Mallard	*Anas platyrhynchos*	Y	No[a]
Canada Goose	*Branta canadensis*	Y	No
Turkey Vulture	*Cathartes aura*	S	No
Wood Duck	*Aix sponsa*	S	No[a]
House Wren	*Troglodytes aedon*	Y	No
Blue Jay	*Cyanocitta cristata*	Y	No
Ring-billed Gull	*Larus delawarwensis*	W	No
Red-bellied Woodpecker	*Melanerpes carolinus*	Y	No
Northern Flicker	*Colaptes auratus*	Y	No
Great Blue Heron	*Ardea herodias*	S	No
Black-crowned Night-heron	*Nycticorax nycticorax*	S	No
American Kestrel	*Falco sparverius*	Y	No
Common Nighthawk	*Chordeiles minor*	S	No
American Robin	*Turdus migratorius*	S	No

Key at end of table.

Table 3-3

BIRDS OBSERVED OR POTENTIALLY EXISTING AT THE RIVERDALE CHEMICAL COMPANY SITE CHICAGO HEIGHTS, ILLINOIS

Common Name	Scientific Name	Season	Observed
Cedar Waxwing	*Bombycilla cedrorum*	Y	No
Prothonotary Warbler	*Protonotaria citera*	S	No
Yellow Warbler	*Dendroica petechia*	S	No
Red-winged Blackbird	*Agelaius phoeniceus*	Y	No
Red-tailed Hawk	*Buteo jamaicensis*	Y	No

[a] Personal conversation with company personnel.

Key:

S = Summer.
Y = Year-round.
W = Winter.

Source: Ecology and Environment, Inc. 2000.

Table 3-4

MAMMALS POTENTIALLY EXISTING AT THE RIVERDALE CHEMICAL COMPANY SITE CHICAGO HEIGHTS, ILLINOIS

Common Name	Scientific Name
Grey Squirrel	*Sciurus carolinensis*
Red Squirrel	*Tamiasciurus hudsonicus*
Eastern Chipmunk	*Tamias striatus*
White-tailed Deer	*Odocoileus virginianus*
Racoon	*Procyon lotor*
Opossum	*Didelphis virginiana*
Striped Skunk	*Mephitis mephitis*
Eastern Cottontail	*Sylvilagus floridanus*
White-footed Mouse	*Peromyscus leucopis*
Deer Mouse	*Peromyscus maniculatus*
Least Shrew	*Cryptotis parva*
Short-tailed Shrew	*Blarina brevicauda*
Muskrat	*Ondatra zibethica*
Woodchuck	*Marmota monax*
Red Fox	*Vulpes vulpes*
Little Brown Bat	*Myotis lucifugus*
Big Brown Bat	*Eptesicus fuscus*
Meadow Vole	*Microtus pennsylvanicus*

Source: Ecology and Environment, Inc. 2000.

Table 3-5
SUMMARY OF RISK ESTIMATES
RIVERDALE CHEMICAL COMPANY SITE

Receptor Group	Chemical	Carcinogenic Risk	Percentage of Risk	Noncancer Hazard Index	Percentage of Hazard Index
Industrial Workers	2,3,7,8-TCDD	1.5E-02	69.3	--	--
	4,4'-DDD	1.8E-06	0.0	--	--
	4,4'-DDT	2.2E-06	0.0	--	--
	Aldrin	4.4E-03	20.5	29.8	75.3
	alpha-BHC	2.4E-06	0.0	--	--
	Benzo[a]pyrene	3.6E-06	0.0	--	--
	beta-BHC	2.4E-06	0.0	--	--
	Chlordane, technical	1.2E-04	0.5	2.3	5.9
	Dieldrin	1.4E-03	6.7	6.2	15.6
	Heptachlor	6.0E-04	2.8	0.9	2.3
	Heptachlor epoxide	1.3E-05	0.1	0.4	1.0
	Toxaphene	1.7E-05	0.1	--	--
	Totals:	2.2E-02	100.0	39.6	100.0
Construction/ Utility Worker	2,3,7,8-TCDD	6.6E-05	14.5	--	--
	Aldrin	2.6E-04	57.1	38.2	74.4
	Chlordane, technical	7.9E-06	1.7	3.4	6.6
	Dieldrin	8.7E-05	19.2	8.2	15.9
	Heptachlor	3.3E-05	7.2	1.1	2.1
	Heptachlor epoxide	7.7E-07	0.2	0.5	1.0
	Toxaphene	9.8E-07	0.2	--	--
	Totals:	4.6E-04	100.0	51.4	100.0

Source: Ecology and Environment, Inc., 2000.

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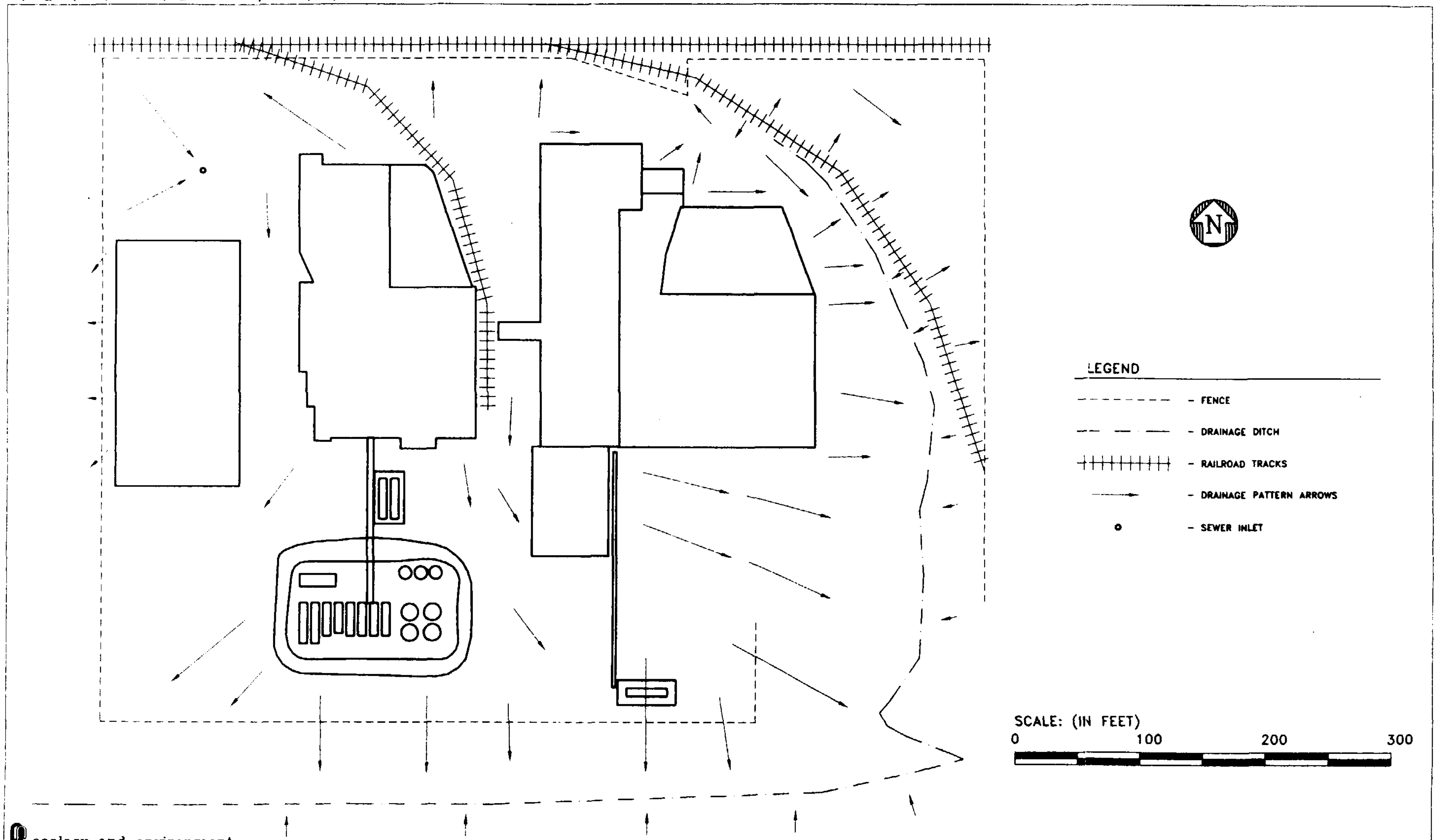
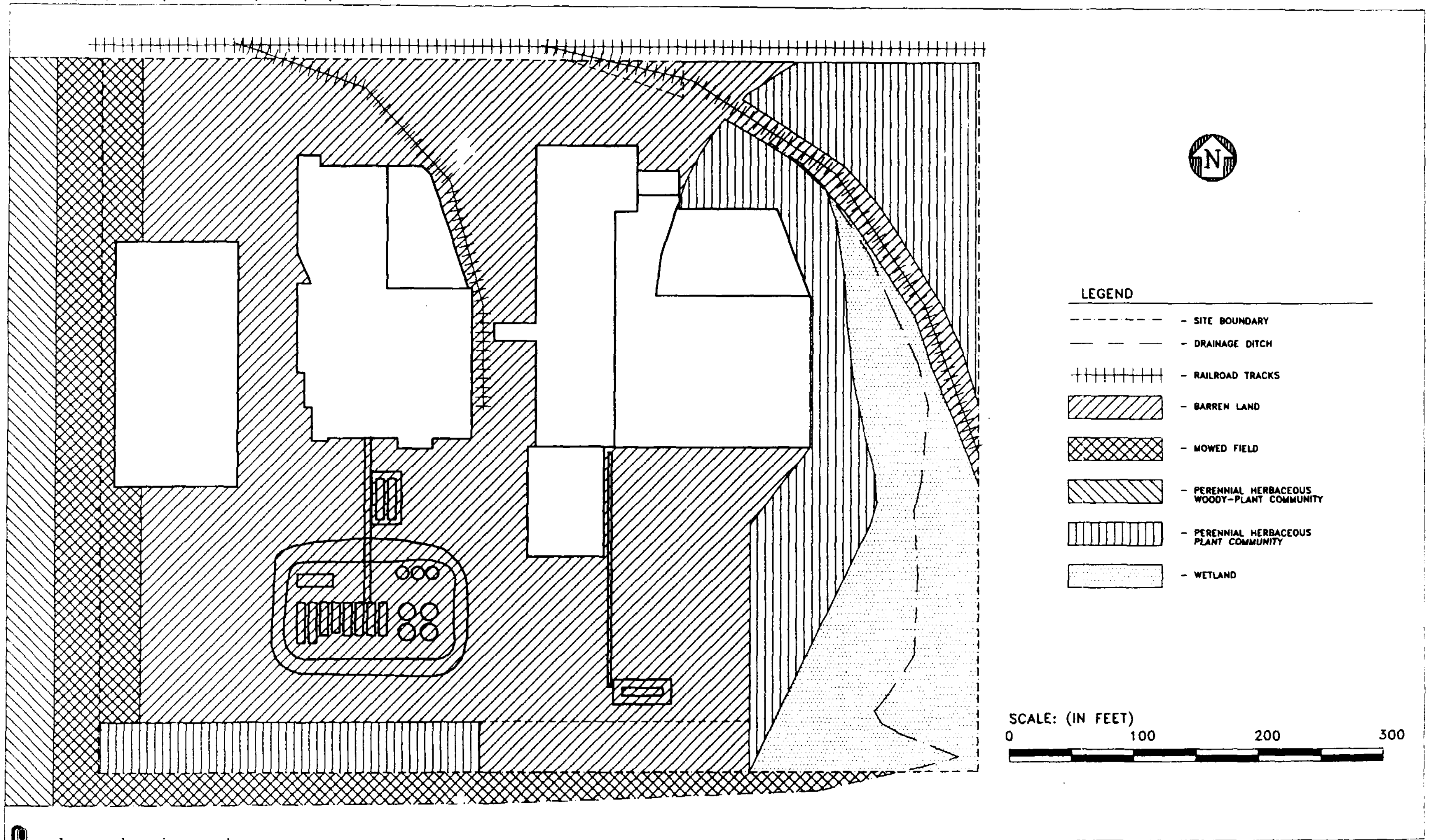


ecology and environment

FIGURE 3-1 SURFACE WATER DRAINAGE MAP
RIVERDALE CHEMICAL CO.
CHICAGO HTS., IL.

H:\ACD_FLS\KJ05\RIVERDALE\RD_HABITATS.DWG/16FEB00/RES/CHICAGO,IL.



ecology and environment

FIGURE 3-2 AREA HABITAT MAP
RIVERDALE CHEMICAL CO.
CHICAGO HTS., IL.

H:\ACD_FLS\KJ05\RIVERDALE\RD_LANDUSES.DWG/16FEB00/RES/CHICAGO,IL.

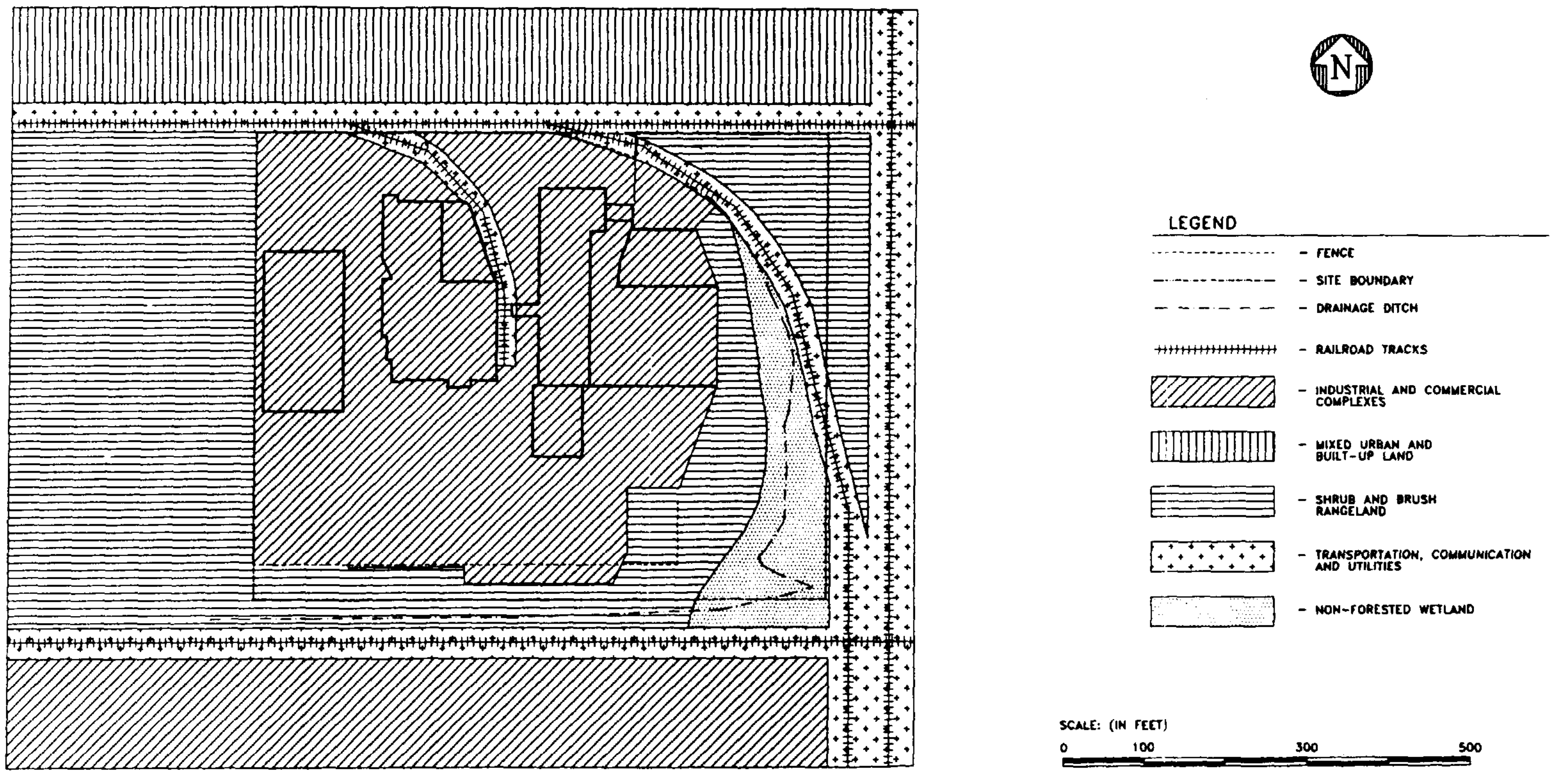


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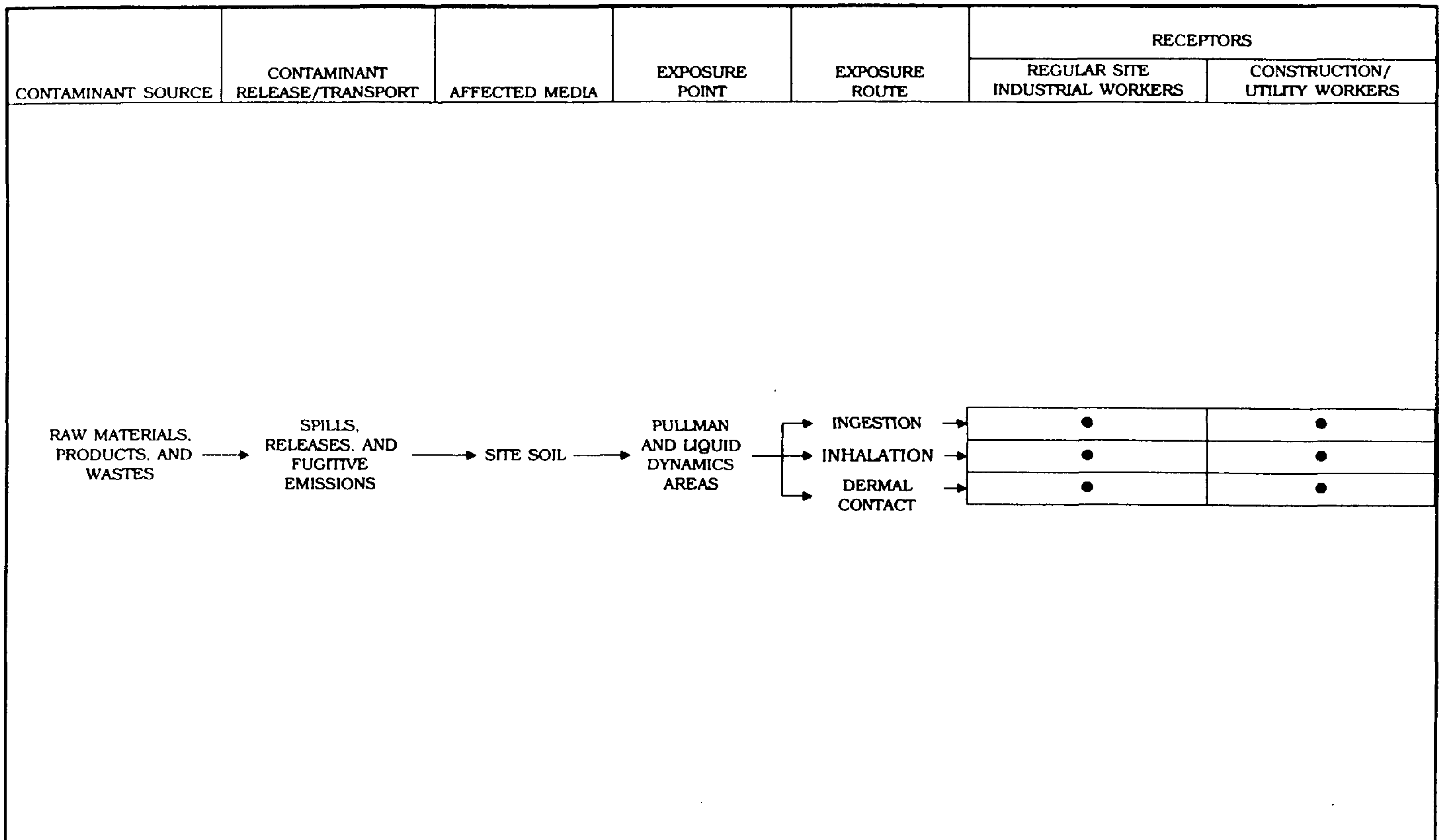
FIGURE 3-3 LAND USES MAP
RIVERDALE CHEMICAL CO.
CHICAGO HTS., IL.



KEY

● Pathway complete or potentially complete.

ecology and environment, inc.

Region 5 - Superfund Technical Assessment and Response Team
33 North Dearborn Street, Chicago, Illinois 60602

TITLE	SHHRE Conceptual Site Model	FIGURE	3-4
SITE	Riverdale Chemical Company Site	SCALE	N/A
CITY	Chicago Heights STATE Illinois	TDD	S05-9908-011A
SOURCE	Ecology and Environment, Inc.	DATE	February 2000

4 Removal Action Scope and Objective

A threat to public health has been established for the Riverdale site in Section 3 of this EE/CA. The NCP § 300.415(b)(2) states that when a threat to public health, welfare, or to the environment has been established, an appropriate removal action may be taken to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a hazardous substance, pollutant, or contaminant. Therefore, a scope of work was developed to take appropriate action to reduce the threat to public health.

RAOs
removal action objectives

ARARs
applicable or relevant and appropriate federal or state requirements

RAC
removal action criteria

TBC
criteria to be considered

RBRGs
risk-based remedial goals

Factors relevant to achieving the scope were selected from the NCP § 300.415(b)(2)(i)-(viii). These factors were used to evaluate the appropriateness of a removal action and were developed into removal action goals. The general NCP goal of "prevention or abatement of actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants" was deemed the most appropriate for the Riverdale site. Thereafter, this goal was developed into site-specific removal action objectives (RAOs) achievable through specified cleanup levels, while remaining within the statutory limits and meeting applicable or relevant and appropriate federal or state requirements (ARARs) to the extent practical. In accordance with the scope of work for this EE/CA, RAOs were developed that will prevent the further exposure of site industrial workers and construction workers to contaminated soils, and will establish the basis for further evaluation of possible ecological impacts to nearby wetlands.

Removal action criteria (RAC) were selected that support the RAOs. The following were reviewed for applicable removal action criteria:

- ARARs;
- Criteria to be considered (TBC);
- Risk-based remediation goals (RBRGs);

- Federal and state guidelines;
- Sample Quantitation Limits (SQLs)

SQLs
Sample Quantitation Limits

CFR
Code of Federal Regulations

USC
United States Code

CERCLA
Comprehensive Environmental Response, Compensation, and Liability Act

PRPs
potentially responsible parties

In this section, the scope of work, goals, and objectives of the removal action, in addition to the removal action criteria, will be presented. Additionally, the ARARs under federal and state environmental laws are identified, the statutory limits on removal actions are defined, and other advisories, criteria, and guidance are presented in this section. Thereafter, contaminated media that exceed the removal action criteria, based on historic (FIT and RI) sampling events, are identified in the removal scope. Finally, a conceptual removal schedule is presented for the removal action.

4.1 Statutory Limits on Removal Actions

Section 300.415(b)(4) of 40 Code of Federal Regulations (CFR) 300 (the NCP) allows at least six months of lead time before cleanup must begin on a non-time-critical removal action, if such action is appropriate to the site conditions. In addition, the lead agency must conduct an EE/CA, or its equivalent, to identify and analyze removal alternatives for a site, pursuant to Section 300.415(b)(4)(i) of the NCP.

Section 300.415(b)(5) of the NCP stipulates that the cost and duration of a removal action must be limited to $2 million and 12 months, respectively. There are two types of exemptions to these statutory limits, in accordance with Section 104(c)(1), 42 United States Code (USC). 9604(c)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): (1) the "emergency" wavier; and (2) the "consistency" waiver. The "emergency" waiver provides additional funding or extends the removal action duration when continued response actions are required to prevent, limit, or mitigate an immediate risk to public health or welfare or to the environment. The "consistency" waiver provides additional funding or extends the removal action time frame to implement a removal action that is otherwise appropriate and consistent with the final response action to be taken. The statutory limits on removal actions apply to fund-financed actions. If potentially responsible parties (PRPs) perform the removal action, the limits do not apply.

4.2 Applicable or Relevant and Appropriate Requirements

Section 300.415(i) of the NCP states that fund-financed removal actions under CERCLA, Section 104, shall, to the extent practicable considering the exigencies of the situation, attain ARARs under federal or state environmental laws. Other advisories, criteria, or guidance may be considered for a particular site, and are referred to as TBC requirements. ARARs are legally binding, unless a waiver is obtained. While TBCs are not legally binding, they were considered along with ARARs during development of RAOs.

SARA
Superfund Amendments and Reauthorization Act

Under CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA), a requirement may be either "applicable" or "relevant and appropriate" to a specific removal action, but not both. Definitions of the components of ARARs are listed below:

- Applicable requirements mean those cleanup standards; standards of control; and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental laws that specifically address a hazardous substance; pollutant, a contaminant, a remedial action, a location, or other circumstances found at a CERCLA site; and

- Relevant and appropriate requirements mean those cleanup standards; standards of control; and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental laws that, while not "applicable" to a hazardous substance, a pollutant, a contaminant, a remedial action, a location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to that particular site.

ARARs are categorized into three main groups: chemical-, location-, and action-specific. Each group is defined below:

- **Chemical-Specific:** Requirements that set technology- or risk-based concentrations/limits in various media. This group can also be used to determine discharge limits, treatment standards, and disposal requirements for removal activities. Chemical-specific ARARs are also used in evaluating the effectiveness of removal alternatives.

- **Location-Specific:** Requirements that provide a basis for assessing removal action alternatives that may be restricted by federal, state, and local laws concerning the proximity of sensitive human populations and environments.

- **Action-Specific:** Requirements that provide a basis for assessing the restrictions for particular treatment and disposal activities related to the management of hazardous wastes. Action-specific requirements govern such categories as air emissions, treatment residues, and off-site disposal policies.

4.2.1 Applicable or Relevant and Appropriate Requirements/To-Be-Considered Requirements for the Riverdale Site

A listing of the potential ARARs for the removal action at the Riverdale site is provided in Appendix E. The primary ARARs and other TBCs that were used to evaluate removal action alternatives for the Riverdale site are discussed in this section.

SWDA
Solid Waste Disposal Act

TSD
treatment, storage, and disposal

LDRs
land disposal restrictions

RCRA was enacted in 1976 as an amendment to the Solid Waste Disposal Act (SWDA) to ensure proper management of solid wastes. The broad goals set by RCRA are:

- To protect human health and the environment from the hazards posed by waste disposal;
- To conserve energy and natural resources through waste recycling and recovery;
- To reduce or eliminate the amount of waste generated, including hazardous waste, as expeditiously as possible; and
- To ensure that wastes are managed in a manner that is protective of human health and the environment.

RCRA consists of three distinct yet interrelated programs in order to achieve these goals. RCRA, Subtitle C, the hazardous waste program, establishes a management system that regulates hazardous waste from the time it is generated until its ultimate disposal. The system established requirements for hazardous waste identification; generators; transporters; treatment, storage, and disposal (TSD) facilities; hazardous waste recycling; land disposal restrictions (LDRs); combustion; permitting; corrective action; enforcement; and state authorization.

The U.S. EPA's *CERCLA Compliance with Other Laws Manual* (U.S. EPA, 1988) states that RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if a combination of the following conditions are met:

1) The waste is a listed or characteristic waste under RCRA: and

2a) The waste was treated, stored, or disposed after the effective date of the RCRA requirements under consideration (in the Riverdale case, November, 1980); or

2b) The activity at the CERCLA site constitutes treatment, storage, or disposal as defined by RCRA.

Determination of whether these conditions are met is contingent upon determinations that a RCRA Subtitle C hazardous waste is present and on the identification of the period of waste management. To determine whether a waste is a listed waste under RCRA, it is often necessary to know the source. However, for the Riverdale site, no information regarding the source of the soil contaminants, has been provided. In reality, the source of the soil contamination is not unknown. Riverdale is the only pesticide manufacturer that has operated the facility. It is more likely than not that the contamination resulted from their operations. However, the PRPs should use available site information, manifests, storage records, and vouchers to determine the nature of the contaminants and the timing and mechanism of release. This information should subsequently be provided to U.S. EPA in an effort to ascertain the RCRA status of these wastes.

The CERCLA Compliance Manual goes on to state that when this documentation is not available, the U.S. EPA may assume that the wastes are not listed RCRA hazardous wastes, unless further analysis or information becomes available that would indicate the wastes are listed RCRA hazardous wastes. Currently, because this information has not been provided for the Riverdale site, an affirmative determination that the wastes are RCRA hazardous wastes, can not be made. As a result, RCRA requirements would not be applicable to CERCLA actions, but may be relevant and appropriate if the action involves treatment, storage or disposal and if the wastes are similar or identical to RCRA hazardous waste.

not listed waste because don't know source

Further discussion of U.S. EPA regulations and policies that apply to contaminated environmental media and their relationship to RCRA can be found in "Management of Remediation Waste Under RCRA," EPA/530-F-98-026, Office of Solid Waste and Emergency Response, October 1998. Pertinent passages include the following:

> "**Contained-in policy**. Contaminated environmental media, of itself, is not hazardous waste and, generally, is not subject to regulation under RCRA. Contaminated environmental media can become subject to regulation under RCRA if they "contain" hazardous waste. As discussed more fully below, EPA generally considers contaminated environmental media to contain hazardous waste: (1) when they exhibit a characteristic of hazardous waste; or (2) when they are contaminated with concentrations of hazardous constituents from listed hazardous waste above health-based levels."

If contaminated environmental media contain hazardous waste, they are subject to all applicable requirements until they no longer contain hazardous waste. The determination that any given volume of contaminated media does not contain hazardous waste is called a "contained-in determination."

TCLP
toxicity characteristic leaching procedure

Under the first criteria, the determination of whether the Riverdale waste exhibits a characteristic of hazardous waste can be answered by the performance of toxicity characteristic leaching procedure (TCLP) tests. Based on the extremely high concentrations of contaminants presented in the RI report, it is probable that Riverdale site soils would be characteristic hazardous waste, if TCLP testing were to be completed. For example, concentrations of chlordane and heptachlor in soil are several orders of magnitude greater than their corresponding TCLP regulatory limit, indicating that the likelihood that Riverdale soils could be considered characteristic hazardous waste is high.

Secondly, constituents of a number of listed hazardous wastes were found in soil at the Riverdale facility including:

- Aldrin	P004
- Dieldrin	P037
- Heptachlor	P059
- Chlordane	U036
- Methoxychlor	U247
- Silvex	U233
- 2,4-Dichlorophenol	U081

A site-specific risk assessment has shown that a number of these chemicals are present in site soils at concentrations above site-specific health-based levels. Therefore, the soils are subject to

RCRA if the hazardous constituents present above health-based levels were from listed hazardous waste.

Therefore, based on the available information, it likely that Riverdale soils would be classified as characteristic hazardous waste, making RCRA Subtitle C requirements applicable to the removal action under consideration. At a minimum, RCRA ARARs would be considered relevant and appropriate, particularly for alternatives that consider excavation and off-site shipping and disposal at a TSD facility.

Specifically, the classification, manifesting and shipping, and disposal of the excavated materials are covered by the following applicable sections of RCRA:

- "Identification and Listing of Hazardous Waste" (40 CFR 261.1 through 261.38);
- "Standards Applicable to Generators of Hazardous Waste" (40 CFR 262.10 to 262.89);
- "Standards Applicable to Transporters of Hazardous Waste" (40 CFR 263.10 to 263.31); and
- "Land Disposal Restriction" (40 CFR 268.1 to 268.50).

As contaminated site soils are excavated, dust containing contamination could be generated. Therefore, dust suppression as mandated by RCRA § 3004 (e) also would be applicable to the excavation activities.

As part of the alternative development presented in Section 5, the use of protective barriers (i.e., caps) is an integral component for several of the alternatives. In a capping scenario, some or all of the contaminated soils would be left in place. In order to determine the appropriate capping requirements, a determination as to whether the contaminated site soil is considered to a be a RCRA hazardous waste, also must be made.

Riverdale has not presented documentation associated with specific chemical usage for aldrin, dieldrin, chlordane, 4, 4'-DDT, 4,4-DDD, heptachlor, methoxyclor and endrin, which if these chemicals were present on site after the inception of RCRA could cause the existing contaminated soil to be classified as a listed hazardous waste. While it is probable but uncertain as to whether the soil contamination could be considered a listed or characteristic hazard waste, RCRA Subtitle C requirements may be relevant and appropriate if the waste at the site is "sufficiently similar" to a hazardous waste. The above referenced EPA manual states the following:

> "...when evaluating whether Subtitle C requirements are relevant and appropriate, the mere presence of hazardous constituents in a CERCLA waste does not mean the waste is sufficiently similar to a RCRA hazardous waste to trigger Subtitle C as an ARAR. Judgement should be used in assessing whether the waste closely resembles a RCRA hazardous waste, considering the chemical composition, form, concentration, and any other information pertinent to the nature of the waste."

In evaluating the chemical composition of the site contaminants, the detected soil contaminants have the same chemical composition and form as would soil contaminated by a listed hazardous waste. The SHHRE has determined that site soil contamination exceeds a cancer risk or 10^{-4} and an HI equal to 1, indicating that the contaminant concentration in the soil is also representative of soil contaminated by a listed hazardous waste. Therefore, RCRA capping requirements would be considered relevant.

The current limestone cover is not an impermeable cap. It allows surface water run-off to infiltrate downward and to come into contact with site contaminants. Therefore, it is necessary to reduce surface water infiltration to prevent further migration of contamination. To accomplish this, RCRA capping requirements are appropriate.

Investigative field work associated with determining the vertical extent of contamination was limited. A total of four composite subsurface soil samples were collected and submitted for herbicide and pesticide analysis. Of the four composite samples collected, three were collected from the 0 foot to 1.5 foot BGS interval, and one was collected from the 1.5 foot to 3 foot BGS interval. Analytical results from all subsurface borings, detected herbicides and pesticides concentration above acceptable risk based concentrations. For the composite sample collected from the 1.5 to 3 foot interval (i.e., the deepest interval sampled), aldrin was detected at a concentration of 170,000 µg/kg, dieldrin was detected at a concentration of 200,000 µg/kg, and chlordane was detected at a concentration of 46,000 µg/kg. Additionally, the investigative field work did not determine the depth to groundwater, nor did it determine whether groundwater has been adversely affected.

Based on the results presented in the RIR, it is uncertain as to the vertical extent of contamination at the Riverdale site. Additionally, it is uncertain as to the horizontal migration of surface water runoff once it has come in contact with the contaminated soil (e.g., is it migrating into the wetlands). Due to these uncertainties, RCRA capping requirements, which are designed and constructed to provide long-term minimization of the migration of liquids through the capped area, are considered appropriate in addition to being relevant.

cm/sec
centimeters per second

OSHA
Occupational Safety and Health Administration

IAC
Illinois Administrative Code

CUOs
clean-up objectives

SSL
Soil Screening Level

RBCA
risk-based corrective action

In 40 CFR 264.310, the requirements for a RCRA cap are stated. A RCRA cap shall have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. Given that site soils have an approximate permeability of 1×10^{-8} centimeters per second (cm/sec), the permeability of the final cover should be equal to or less than 1×10^{-8} cm/sec.

Occupational Safety and Health Administration (OSHA). Because implementation of the removal alternatives involves hazardous waste, OSHA (29 CFR 1910.120) requirements for workers engaged in response or other hazardous waste operations would be considered applicable to the Riverdale site.

TACO. Thirty-five Illinois Administrative Code (IAC), 742, entitled Tiered Approach to Corrective Action Objectives, is Illinois EPA's method for developing remediation objectives (hereafter referred to as clean-up objectives (CUOs) for contaminated soil and groundwater in Illinois. These CUOs protect human health and take site conditions and land use into account. CUOs generated by TACO are risk-based and site-specific.

There are three tiers of CUOs in TACO. A Tier 1 evaluation compares the concentration of contaminants detected at a site to the corresponding CUOs contained in "look-up" tables. These CUOs are based on simple, conservative models. A Tier 2 evaluation uses risk-based equations from soil screening level (SSL) and risk-based corrective action (RBCA) approaches, and allows the use of site-specific information to calculate less stringent, but equivalently protective CUOs as Tier 1.

A Tier 3 evaluation allows the use of alternative risk-based parameters and factors not available under a Tier 1 or Tier 2 evaluation, to be considered when CUOs are developed.

For the Riverdale site, soil contamination exceeding the CUOs will probably be present on site at the completion of the removal action. Therefore, TACO would require institutional controls, restrictive covenants and deed restrictions, and/or negative easements be placed on the site.

Under TACO, two of the assumptions for using institutional controls are having a target cancer risk greater than 1 in million (Section 742.1000 a 2) and/or a target HQ greater than 1 (Section 742.1000 a 3). If an engineered barrier is proposed as an alternative, the barrier should cover all soils that have a risk greater that 1×10^{-6} and/or an HQ greater than 1.

Finally, in order for TACO to be considered an ARAR, it must be as stringent as the federal guidelines. Because TACO would allow for a simple engineered barrier (i.e., limestone) to be used to cover a characteristic and/or listed hazardous waste, it cannot be considered an ARAR. Therefore, TACO is a TBC.

4.3 Removal Action Objectives

RAOs are medium-specific goals for protecting human health and the environment. The RAOs for the Riverdale site were established under the broad guideline of being protective of human health and the environment, while remaining within statutory limits and attaining ARARs to the extent practicable. The RAOs were developed to reduce the potential for exposure through specific removal actions (i.e., institutional controls, containment, removal, and/or treatment). During the development of the RAOs, ARARs and contaminant concentrations were evaluated to establish risk-based preliminary remediation goals and to determine the scope of the removal action(s) necessary to meet the objectives. The preliminary risk-based remediation goals proposed for the Riverdale site are presented in Section 4.3.1.

PRGs
preliminary remediation goals

As shown in Appendix C, Tables 10.1 and 10.2, the estimated cancer risks and noncancer hazards to site workers were due to a combination of incidental ingestion and dermal contact with contaminated soil. The RAOs, therefore, are to reduce potential exposure to soil contaminants either by reducing the contaminant concentrations present, or by reducing or eliminating the opportunity for soil contact, or both. Preliminary remediation goals

(PRGs) were developed for exposure scenarios and COPCs estimated to pose risks above the generally acceptable range. For known or suspected carcinogens, the acceptable risk of excess cancers is 10^{-4} to 10^{-6}. For noncarcinogens, the acceptable risk corresponds to an HI of 1.

Based on the identified ARARs and TBCs, and the need to reduce the potential threat to human health and the environment, the following general RAOs were developed for the Riverdale site:

- Reduce the potential for industrial worker and construction worker exposure to soil contaminants either by reducing the contaminant concentration present, or by reducing or eliminating the opportunity for soil contact, or both.
- Delineate the potential impact that past site activities and the recent site fire may have had on the wetlands surrounding the site;
- Remediate (if necessary) the impacts that past site activities and the recent site fire may have had on the wetlands surrounding the site; and
- Minimize stormwater contact with raw chemicals stored outside and the associated stormwater runoff from entering the surrounding wetlands.

4.3.1 Preliminary Remediation Goals

Values considered as PRGs included:

- ARARs,
- Site-specific RBRGs,
- Federal and state guidelines,

Site-specific risk-based concentrations are the contaminant concentrations in soil that correspond to the desired target risk. In accordance with U.S. EPA guidance (U.S. EPA 1991b), a target risk of 1×10^{-6} was used as a point of departure. Site-specific RBRGs were calculated as follows:

$$RBRG = \frac{EPC \times TR}{ERR}$$

where:

RBRG	=	Risk-based remediation goal;
EPC	=	Exposure point concentration;
TR	=	Target risk;
ERR	=	Estimated receptor risk;

RBRGs corresponding to a target cancer risk of 1×10^{-6} or an HI of 1 for each COPC are provided in Tables 4-1 and 4-2. All of the values considered as potential PRGs, ARARs, and other values, also are summarized in these tables.

4.3.2 Selection of PRGs

The values selected as PRGs, the rationale for their selection, and the risks and hazards associated with the PRGs are summarized in Tables 4-3 and 4-4. In accordance with the NCP (U.S. EPA 1992b), the PRGs were based on ARARs, unless no ARAR was available or the ARAR was not sufficiently protective due to simultaneous exposure by multiple pathways or to multiple chemicals of concern.

TACO
Tiered Approach to Corrective Action Objectives

There are no chemical-specific federal ARARs for contaminants in soil. Illinois' Tiered Approach to Corrective Action Objectives (TACO; Illinois EPA 1998), which are promulgated rules and therefore potential ARARs, however, as discussed in Section 4.2, are not as strict as federal guidelines for this site and are therefore classified as To-Be-Considered criteria rather than ARARs.

RBRGs corresponding to a total estimated cancer risk of 1×10^{-5} or a total hazard index of 1, for all COPCs affecting the li[illegible]r, whichever was lower, were selected as PRGs for the chemicals of concern.

4.3.3 Alternative Remediation Goals

If all of the COPCs are cleaned up to their nominal PRGs throughout the site, a larger area will be remediated than would be necessary to meet target cancer risk and HI. At many sampling locations one or more of the COPCs was not detected, or was present at a level that was already below its PRG. If the remaining COPCs that are present above their PRGs are still cleaned up to their nominal PRGs, the total residual cancer risk and noncancer hazards would end up lower than (possibly substantially lower than) the target cancer risk and HI. This outcome is certainly acceptable from a health protection stand point, but it could mean that a larger area and a larger volume of soil would be remediated than would be necessary to achieve the selected target cancer risk and noncancer hazard. This, in turn, could adversely affect the applicability, practicality, and/or cost-effectiveness of various remedial alternatives.

The PRGs derived in the previous section are designed to achieve the RAO of a total cancer risk no greater than 1×10^{-5}, and a total hazard index no greater than 1 for all of the COPCs affecting the liver when ALL of the COPCs are present at their PRGs. To accomplish this goal the target CR was apportioned equally among all of the COPCs and the target HI was apportioned equally among all of the COPCs that affect the liver. However this is only one of any number of acceptable ways (and not necessarily the most advantageous way) of apportioning the target CR and HI among the COPCs that will achieve the RAO.

An alternative approach to setting remediation goals is to state the remediation goals in terms of the target cancer risk and noncancer HI that must be achieved rather than specific concentrations for each COPC. Under this approach, any combination of COPC concentrations that results in a total residual cancer risk and HI no greater than the selected target levels is acceptable. The advantage of this approach is that it achieves the desired degree of health protection while focusing remedial efforts on the areas where they are truly needed. In order to implement this approach, the total cancer risk and HI is calculated for each sampling location using the COPC concentrations actually measured at those locations. In accordance with standard EPA risk assessment procedures, COPCs that are not detected at a sampling location are assumed to be present at one half of the sample detection limit. Remedial measures, then, are only required at locations where the total estimated cancer risk or noncancer hazard exceeds its target level. Figures 4-1 and 4-2 show the distributions of the total estimated cancer risk and the total noncancer HI for permanent industrial workers and construction/utility workers, respectively, at the Riverdale site.

This location by location approach is especially suitable for protecting construction and utility workers whose exposure to soil contaminants is likely to occur at a few specific locations where they are actually working, rather than to contaminants site-wide. However, it is also protective for general industrial workers whose exposure may be to site-wide contamination because if each location is remediated so that its total residual cancer risk and noncancer hazard do not exceed the target levels, then logically, the site-wide risks and hazards also cannot exceed the target levels.

4.4 Removal Action Scope

The proposed scope of the removal action consists of those areas of the site containing media with concentrations of COPCs posing total cancer risks or HIs above target levels. The areas enclosed by the hatched lines on Figures 4-1 and 4-2 are the areas that exceed the maximum cancer risk (10^{-4}) or noncancer Hazard Index (HI=1) generally considered acceptable by U.S. EPA. These are the minimum areas that will require remediation; therefore, these are the areas that were used as the basis for the evaluation of remedial alternatives provided in Sections 6 and 7. Because the Riverdale site is an active facility, only soils that are readily accessible (i.e., not located beneath facility buildings) are being addressed.

Kriging is a geostatistical procedure for estimating the spatial distribution of a parameter based on a set of discrete samples.

The contour maps were produced using Surfer® Version 6. The contours shown are statistical estimates of the distribution of hazards and risks at the site based on the contaminant concentrations measured at the various sampling locations. The contours were generated using the program's default kriging option and assume that the contaminant concentrations, and associated hazards and risks, are lognormally distributed. Based on the contours shown in Figures 4-1 and 4-2, approximately 117,000 square feet of the site pose a total cancer risk greater than 1×10^{-4} to general site industrial workers, while approximately 55,000 square feet pose a total noncancer HI greater than 1 to construction or utility workers engaged in subsurface activities that disturb site soils. These areas only include the open parts of the site where the soil is accessible. They do not include areas covered by buildings or former building foundations.

There are limited data regarding the depth of contamination at the site. However, the RI identified contamination as deep as 8 feet BGS. Although contamination above the RBCs was detected at 8 feet BGS, most of the contamination was detected in the 0- to 3-foot-BGS interval. In order to develop volume estimates, removal alternatives, and construction costs, it is necessary to assume depth of contamination. Because any removal alternative that involves excavation will have confirmation sampling as a component to ensure that total cancer and HI target levels are achieved, it was assumed that the depth of contamination extends to a maximum of 2.5 feet BGS in all areas where surface soil risks exceed the target levels. Using the modeled areas of contamination and the assumed depth of contamination, volume estimates could be generated for use in the removal alternative development and evaluation. For the industrial worker scenario, approximately 10,900 cubic yards of soil exceeded a risk of 1×10^{-4}, and for the construction worker scenario, approximately 5,100 cubic yards of soil exceeded either a risk of 1×10^{-4} or an HI of 1.

4.5 Removal Action Schedule

PRSCs
post-removal site controls

O&M
operation and maintenance

The final removal action schedule will be determined by U.S. EPA in conjunction with the PRPs. The estimated time frames to implement the individual removal action alternatives for a site of this size can range generally from one month to six years, and up to 30 years for post-removal site controls (PRSCs). PRSCs consist of system operation and maintenance (O&M). Each of the proposed removal action alternative is described in Section 5.

Based on the removal action scope described above, a waiver of the 12-month statutory time limit for the removal action would not be required. The "consistency" wavier would not have to be obtained because the site owners are anticipated to conduct the removal action.

These time frames do not include a public comment period for the final EE/CA, nor do they include time required for engineering design. As in all schedules for environmental construction, weather can impact work progress. The time frames presented, however, account for normally inclement weather and associated shutdown periods.

Table 4-1
VALUES CONSIDERED AS PRGs FOR HUMAN HEALTH
RIVERDALE CHEMICAL COMPANY SITE

Medium:	Soil
Receptor Population:	Current Industrial Workers
Location:	Onsite

Chemical of Concern	Most Restrictive ARAR (mg/kg)	Most Restrictive ARAR Source	Risk/Hazard at ARAR	Risk-Based Remedial Goals - Cancer (1) (mg/kg)	Risk-Based Remedial Goals - Non-Cancer (2) (mg/kg)	Other Value (mg/kg)	Other Value Source
2,3,7,8-TCDD	NA	--	--	0.000024	--	NA	--
4,4'-DDD	NA	--	--	20.9	--	24.0	(3)
4,4'-DDT	NA	--	--	14.7	--	17.0	(3)
Aldrin	NA	--	--	0.12	17.8	0.3	(3)
alpha-BHC	NA	--	--	0.32	--	0. 9	(3)
Benzo[a]pyrene	NA	--	--	0.24	--	0. 8	(3)
beta-BHC	NA	--	--	1.01	--	NA	--
Chlordane, technical	NA	--	--	9.2	472	4.00	(3)
Dieldrin	NA	--	--	0.15	34.0	0.40	(3)
Heptachlor	NA	--	--	0.32	209	1.00	(3)
Heptachlor epoxide	NA	--	--	0.23	7.9	0.60	(3)
Toxaphene	NA	--	--	1.9	--	5.20	(3)

(1) Values correspond to an excess cancer risk of 10^{-6}.
(2) Values correspond to a hazard index of 1.
(3) Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties, Industrial/Commercial Worker - ingestion exposure. (Illinois TACO rules Appendix B, Table B.)
ARAR: Applicable or relevant and appropriate requirement.
mg/kg: milligrams per kilogram.
NA: Not Available.
--: Not applicable.
PRG: Preliminary remediation goal.

Source: Ecology and Environment, Inc., 2000.

Table 4-2
VALUES CONSIDERED AS PRGs FOR HUMAN HEALTH
RIVERDALE CHEMICAL COMPANY SITE

Medium:	Soil
Receptor Population:	Current/Future Construction Workers
Location:	Onsite

Chemical of Concern	Most Restrictive ARAR (mg/kg)	Most Restrictive ARAR Source	Risk/Hazard at ARAR	Risk-Based Remedial Goals - Cancer (1) (mg/kg)	Risk-Based Remedial Goals - Non-Cancer (2) (mg/kg)	Other Value (mg/kg)	Other Value Source
2,3,7,8-TCDD	NA	--	--	0.000352		NA	--
Aldrin	NA	--	--	2.0	13.9	6.1	(3)
Chlordane, technical	NA	--	--	140	326	12.0	(3)
Dieldrin	NA	--	--	2.4	25.6	7.8	(3)
Heptachlor	NA	--	--	5.8	174	28.0	(3)
Heptachlor epoxide	NA	--	--	3.9	6.1	2.7	(3)
Toxaphene	NA	--	--	32.2		110.0	(3)

(1) Values correspond to an excess cancer risk of 10^{-6} for individual COCs.
(2) Values correspond to a hazard index of 1 for individual COCs.
(3) Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties, Construction Worker - ingestion exposure. (Illinois TACO rules Appendix B, Table B.)
ARAR: Applicable or relevant and appropriate requirement.
mg/kg: milligrams per kilogram.
NA: Not Available.
--: Not applicable.
PRG: Preliminary remediation goal.

Source: Ecology and Environment, Inc., 2000.

3/1/00

Table 4-3
RISKS AND HAZARDS ASSOCIATED WITH PRGs FOR HUMAN HEALTH
RIVERDALE CHEMICAL COMPANY SITE

Medium:	Surface Soil
Receptor Population:	Current Industrial Workers
Location:	Onsite

Chemical of Concern	Maximum Concentration (mg/kg)	PRG (1) (mg/kg)	Basis for PRG	Cancer: Risk at PRG (1)	Noncancer: Target Organ	Noncancer: Hazard at PRG
2,3,7,8-TCDD	0.364	0.000022	(2)	9.1E-07	--	--
4,4'-DDD	37.0	19.0	(2)	9.1E-07	--	--
4,4'-DDT	33.0	13.4	(2)	9.1E-07	--	--
Aldrin	530	0.11	(2)	9.1E-07	Liver	0.006
alpha-BHC	2.6	0.29	(2)	9.1E-07	--	--
Benzo[a]pyrene	4.0	0.21	(2)	9.1E-07	--	--
beta-BHC	2.4	0.92	(2)	9.1E-07	--	--
Chlordane, technical	1,100	8.40	(2)	9.1E-07	Liver	0.018
Dieldrin	210	0.13	(2)	9.1E-07	Liver	0.004
Heptachlor	190	0.29	(2)	9.1E-07	Liver	0.001
Heptachlor epoxide	3.0	0.21	(2)	9.1E-07	Liver	0.026
Toxaphene	160	1.7	(2)	9.1E-07	--	--
			Totals:	1.0E-05	Liver	0.055

(1) The PRGs for individual chemicals of concern had to be adjusted downward to achieve a total cancer risk of 1.0e-5.
(2) Site-specific risk-based concentration.
mg/kg: milligrams per kilogram.
PRG: Preliminary remediation goal.

Source: Ecology and Environment, Inc., 2000.

Table 4-4
RISKS AND HAZARDS ASSOCIATED WITH PRGs FOR HUMAN HEALTH
RIVERDALE CHEMICAL COMPANY SITE

Medium:	Surface and Subsurface Soil
Receptor Population:	Current/Future Construction Workers
Location:	Onsite

Chemical of Concern	Maximum Concentration (mg/kg)	PRG (3) (mg/kg)	Basis for PRG	Cancer: Risk at PRG (1)	Noncancer: Target Organ	Noncancer: Hazard at PRG (1)
2,3,7,8-TCDD	0.364	0.000639	(1)	1.8E-06		
Aldrin	530	3.5	(2)	1.7E-06	Liver	0.254
Chlordane, technical	1,100	82.7	(2)	5.9E-07	Liver	0.254
Dieldrin	210	4.4	(1)	1.8E-06	Liver	0.170
Heptachlor	190	10.5	(1)	1.8E-06	Liver	0.060
Heptachlor epoxide	3	1.6	(2)	4.0E-07	Liver	0.254
Toxaphene	160	40.9	(1)	1.8E-06		
			Totals:	9.98E-06	Liver	0.993

(1) Cancer risk.

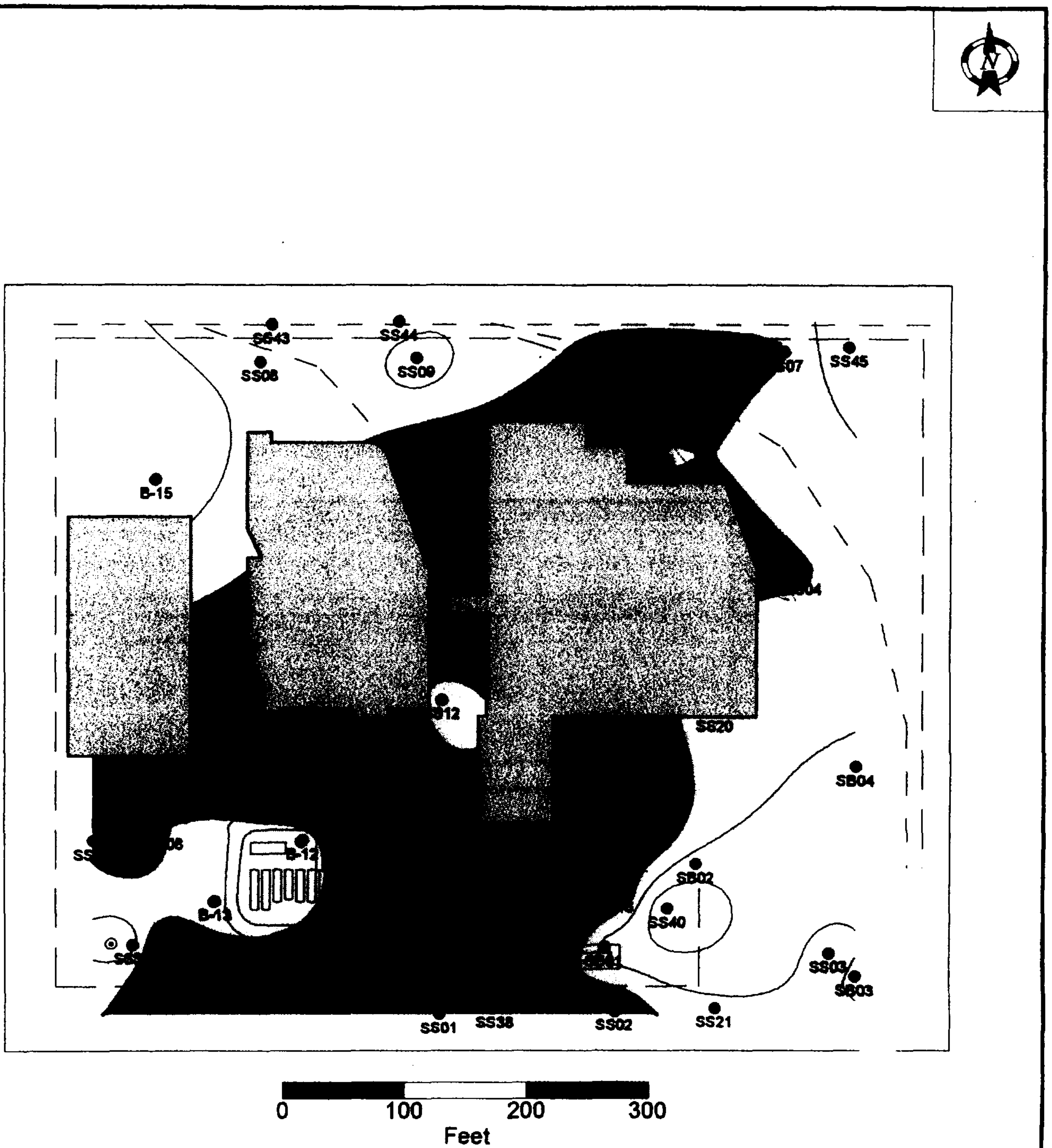
(2) Noncancer hazard.

(3) PRGs were adjusted so both the total cancer risk and the total hazard index approached their target values.

mg/kg: milligrams per kilogram.

PRG: Preliminary remediation goal.

Source: Ecology and Environment, Inc., 2000.



Legend

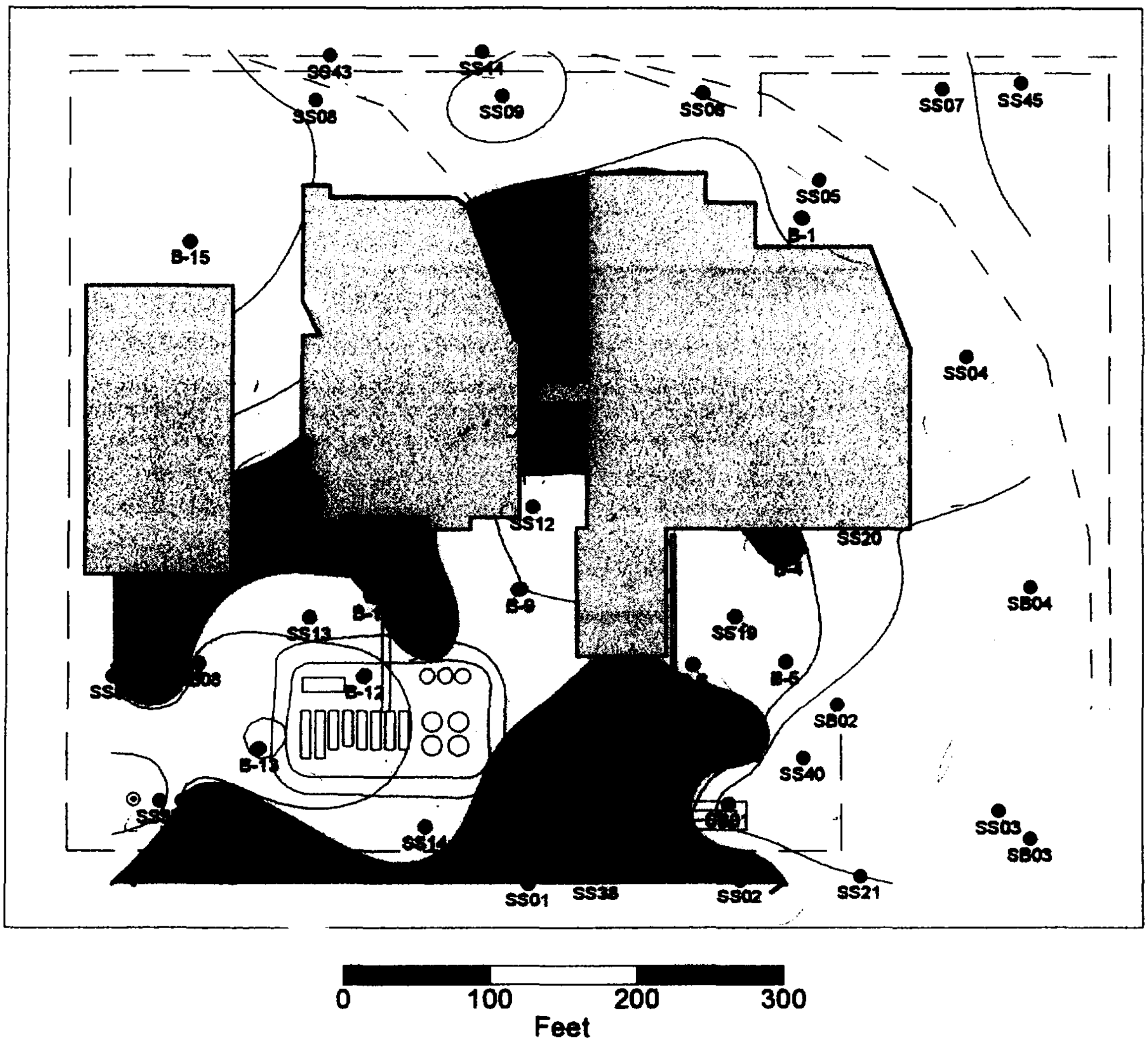
- Total Cancer Risk > 1 x 10^{-6}
- Total Cancer Risk > 1 x 10^{-5}
- Total Cancer Risk > 1 x 10^{-4}
- Total Noncancer Hazard Index > 1

Hachures: Alternative 5 Area of Excavation

ecology and environment, inc.

Region 5 - Superfund Technical Assessment and Response Team
33 North Dearborn, Suite 900, Chicago, Illinois 60602

TITLE	Industrial Worker: Total Cancer Risk and Noncancer Hazard	FIGURE	4-1
SITE	Riverdale Chemical Company	SCALE	(See above)
CITY	Chicago Heights, Illinois	TDD	S05-9908-011
SOURCE	Ecology and Environment, Inc.	DATE	March 2000



Legend

- Total Cancer Risk > 1 x 10^{-6}
- Total Cancer Risk > 1 x 10^{-5}
- Total Cancer Risk > 1 x 10^{-4}
- Total Noncancer Hazard Index > 1

Hachures: Alternative 4 Area of Excavation

ecology and environment, inc.

Region 5 - Superfund Technical Assessment and Response Team
33 North Dearborn, Suite 900, Chicago, Illinois 60602

TITLE	Construction Worker: Total Cancer Risk and Noncancer Hazard	FIGURE	4-2
SITE	Riverdale Chemical Company	SCALE	(See above)
CITY	Chicago Heights, Illinois	TDD	S05-9908-011
SOURCE	Ecology and Environment, Inc.	DATE	March 2000

5 Identification of Alternatives

In this section, removal action alternatives for soils at the Riverdale site are identified and described. Alternatives that remove and/or cover the contaminated materials with a clean layer, and alternatives that restrict future land use, such as institutional actions, coupled with location-specific removals, are described in this section. In Section 6, the alternatives are individually evaluated using the three broad criteria of effectiveness, implementability, and cost. A comparative analysis of the alternatives using these three criteria is presented in Section 7.

Based on conversations with U.S. EPA, the following removal action alternatives were selected:

- Alternative 1: No Action;
- Alternative 2: Maintain Limestone Cover and Implement Institutional Controls;
- Alternative 3: Install Sitewide Enhanced Asphalt Cap;
- Alternative 4: Localized Hot Spot Removal and Install An Enhanced Asphalt Cap; and
- Alternative 5: Excavation and Off-Site Incineration.

The removal action alternatives identified above and developed below integrate the actions needed to reduce or eliminate the known risks in the industrial portion of the site and to identify potential ecological risks in the wetlands and other nonindustrial areas.

5.1 Alternative 1: No Action

Under this alternative, no further action would be taken to remove, treat, or contain contaminated soils at the Riverdale site. The no-action alternative is included as a requirement of the NCP to provide a basis of comparison for the remaining alternatives. Because contaminated media would remain in place, the potential for continued migration of, and exposure to, contaminants would not be mitigated.

5.2 Common Components

Except for the no-action alternative, there are certain administrative, investigative, and construction elements that are included as part of each of the alternatives selected for evaluation. These common components are presented in this subsection and are to be considered an integral element for all of the removal action alternatives. The costs associated with the components are included in this section and are in addition to the costs associated with Alternatives 2 through 5 (i.e., common component costs are not included). The costs associated with implementing Alternatives 2 through 5 are presented in section 6, and the common component costs have not been included, so a more thorough comparative cost analysis of alternatives (see Section 6) can be performed.

5.2.1 Institutional Controls

Both the SHHRE and the risk assessment in the RI report assume that the site will continue to be used for commercial or industrial purposes, and that residential use of the site will not occur. Accordingly, neither the SHHRE nor the RI risk assessment addresses potential risks to future site residents. No residential use of the site is a basic premise underlying all of the action alternatives presented in this EE/CA. Therefore, institutional controls, in the form of deed restrictions that prohibit residential use of the site, are an essential element of the general response measures for the site.

OSWER
Office of Solid Waste and Emergency Response

As stated in Office of Solid Waste and Emergency Response (OSWER) Directive No. 9335.704, "Land Use in the CERCLA Remedy Selection Process,"

> "... a remedial alternative may include leaving in place contaminants in soil at concentrations protective for industrial exposure, but not protective for residential exposures. In this case, institutional controls should be used to ensure that industrial use of the land is maintained and to prevent risks from residential exposure..."

The Directive further states,

> "These controls either prohibit certain kinds of site uses or, at a minimum, notify potential owners or land users of the

> presence of hazardous substance remaining on the site at levels that are not protective for all uses. Where exposure must be limited to assure protectiveness, a deed notice alone generally will not provide a sufficiently protective remedy."

While deed restrictions would be placed on the Riverdale facility, preventing it from being used for future residential development, the deed restrictions would also include language identifying areas of soil contamination, potential contaminant concentrations, and the associated exposure risks (i.e., cancer and noncancer) that are present on site after the completion of the selected removal action.

The cost associated with implementing the deed restrictions is estimated to be $2,500. Additionally, the time frame to implement the deed restrictions is estimated to be 6 months after the completion of the selected removal action.

5.2.2 Perform Ecological Sampling

Based on the findings of E & E's ecological survey and the high concentrations of pesticides and other compounds detected in site soils, there is a potential for contaminants to adversely affect the surrounding ecological habitats. The previous investigations performed at the Riverdale site focused on the industrial portion of the site. Therefore, as part of the removal action alternatives proposed in this EE/CA, soil, surface water, and sediment sampling of the wetland habitat on and adjacent to the site was included as a common component.

In order to fully characterize the possible extent of contamination in these areas, soil, surface water, and sediment samples would be collected in the wetlands located in the southeast corner, in the upstream and downstream portions of the drainage ditch located to the south, and in off-site areas that have drainage from site structures located along the west side. Additionally, background sampling should be performed to develop a baseline for comparison.

A preliminary cost estimate for performing the ecological sampling was prepared as part of this EE/CA. It is assumed that 15 soil and/or sediment samples and two duplicate samples (for a total of 17 samples) will be collected and analyzed for dioxins, pesticides, and herbicides. While VOCs and SVOCs were detected in on-site soils, only dioxins, pesticides, and herbicides were selected because they were identified by the RI as having the highest surface and subsurface soil concentrations, and would be the contaminants of potential ecological concern. It is estimated that the ecological sampling and associated analyses and reporting will cost $52,000. Table 5-1 presents a breakdown of the cost estimate.

The cost estimate for this common component addresses one round of ecological sampling and reporting. If the findings indicate that off-site contaminant levels may be adversely affecting the adjacent ecological habitats, then additional investigation and/or remediation may be required. Costs for these additional actions cannot be estimated accurately at this time, and therefore are not included in this EE/CA.

5.2.3 Construct a New Raw Material Storage Area

A majority of the raw chemicals used as feed material for the formulation of pesticides and herbicides at the Riverdale site are stored outside on the limestone cover in the southeast portion of the site. Containerized process water to be recycled back into the process and spent process water classified as a hazardous waste also are stored in this area. The natural drainage of this area routes stormwater runoff through the material storage area and into the wetland area. Except for the recent fire, no releases in this area have been reported; however, stormwater and runoff come into contact with the raw materials containers and then drain into the wetlands. Based on the results of the ecological survey and the need to minimize the potential adverse impact associated with the release of raw materials into the wetlands, a new raw materials storage area is included as a common component of each of the removal action alternatives.

There are numerous potential designs for minimizing stormwater contact and runoff from the raw materials storage area. Three possible alternatives are asphalt paving and regrading so that stormwater runoff is diverted away from the wetlands, building a dedicated storage building and construction of a bermed concrete storage pad with an incorporated storm water drainage system. Altering the grade so that stormwater is diverted away from the wetlands and routed to the storm sewers was not considered further because if there is a release, then spilled chemicals may reach the sewer before response actions are implemented. Construction of a dedicated storage building was not considered further because of the associated high costs.

While Riverdale personnel are refurbishing the remaining portion of the warehouse, which did not burn down during the recent fire, it is uncertain whether the warehouse's storage will fully accommodate all of the material handling needs. Therefore, for the purposes of developing a cost for this common action alternative item, it is assumed that a 6-inch-thick reinforced concrete pad with 3-foot-high by 6-inch-wide surrounding walls will be constructed. The surface area of the storage berm is assumed to be 150 feet by 150. An access ramp equipped with a watertight gate will allow fork lifts to gain access to the stored chemicals. While a protective roof could be placed over the berm to minimize accumulation of stormwater, the cost associated with installation was deemed excessive. Therefore, a subsurface pipe fitted with a shut off valve would connect the bermed storage pad to the local storm drains. The valve will remain in the closed position to prevent loss following a spill and will be opened only to drain stormwater. By leaving the storage area open to the atmosphere, there is no need for heating and/or ventilation.

Utilizing the above conceptual design assumptions, a preliminary cost estimate was developed for this EE/CA. It is estimated that the raw materials storage area will cost $179,000. Table 5-2 presents a breakdown of the cost estimate.

5.3 Alternative 2: Maintain Limestone Cover and Implement Institutional Controls

For this alternative, the current IRM (i.e., limestone cover) would be maintained and institutional controls would be implemented to reduce the potential for exposure to COPCs left in the site soils above the risk-based cleanup criteria.

Riverdale personnel estimated that the current limestone cover is approximately 1 foot thick. In order to maintain the current thickness of the cover, limestone would have to be trucked to the site and spread routinely. A local quarry provides limestone; therefore, there is a readily available supplier. As the limestone is delivered, the trucks used to haul the stone can gradually drop the stone while moving, thereby minimizing the grading equipment requirements. Additionally, local on-site truck traffic would compact the newly delivered stone.

The distinctive cost component for this alternative is the PRSC cost associated with maintaining the limestone cover. For the purposes of evaluating this alternative and estimating the associated costs, it is assumed that 3 inches of limestone would have to be place over a 189,000-square-foot area (i.e., the existing area currently covered) on a yearly basis. The existing site fence was installed as part of the IRM. However, the costs associated with maintaining the security fence surrounding the site and the security system currently in place are considered to be part of the normal cost of business associated with operating a production facility in Chicago Heights.

Since the limestone cover is currently in place, an estimate of time associated with its implementation is not necessary. While the limestone cover would have to be maintained in perpetuity, for the purposes of developing a cost estimate, it is assumed that the PRSC activities would be performed over a 30-year period.

5.4 Alternative 3: Install Sitewide Enhanced Asphalt Cap

For Alternative 3, an enhanced asphalt cap would be installed on top of the existing limestone cover. Asphalt would be placed on top of all accessible areas that have on-site surface soil and/or subsurface soil contamination exceeding the target risk levels for the industrial worker scenario, as determined using the data presented in Section 4 (see Figure 4-1).

Based on the findings of the RI, the SHHRE and the risk-based contour mapping, it was estimated that approximately 189,000 square feet of the facility would require the placement of asphalt (i.e., approximate extent of soil contamination exceeding a target cancer risk level of 10^{-4} and an HI greater than 1 for industrial workers). Given the irregular shapes associated with the areas of contamination, the data gaps, and in order to be conservative, a sitewide cap was selected for this alternative.

Before placement of the asphalt, the entire site would be regraded to facilitate stormwater drainage to the local sewer system. Riverdale personnel are reportedly conducting a preliminary engineering design to upgrade the existing on-site storm sewers. It has been assumed that the Riverdale's storm sewer upgrade will be compatible with the installation and operation of the enhanced asphalt cap. Therefore, this alternative does not account for the need to upgrade the sewer tie-ins.

MatCon Modified Asphalt Technology for Waste Containment

While the use of asphalt is an established construction technique, several advances in asphalt technology have increased its wear resistance while achieving an overall decrease in permeability. Products such as the Modified Asphalt Technology for Waste Containment (MatCon) system developed by Wilder Construction Co. are currently being marketed. These products have been demonstrated to provide superior containment properties when compared to standard asphalt, and the technology has been applied successfully by the U.S. EPA for the Tricounty Landfill located in Elgin, Illinois.

While using standard asphalt aggregate, the enhanced asphalt system utilities a specially designed binding agent to decrease permeability while providing a long-term wear-resistant surface. Typically, a 4-inch layer of enhanced asphalt will achieve a hydraulic permeability of 1×10^{-8} cm/sec. Advantages of an enhanced asphalt cap over standard capping materials are as follows:

- Unlike clays, enhanced asphalt does not crack under arid conditions;

HDPE
high-density polyethylene

UV
Ultraviolet

- Unlike high-density polyethylene (HDPE) liners, enhanced asphalt will not lose its plasticity under arid conditions, nor will it become brittle during cold periods;
- Standard asphalt caps require a minimum thickness of 6 inches, whereas enhanced asphalt requires a thickness of 4 inches; and
- Enhanced asphalt is resistant to ultraviolet (UV) damage.

Typical asphalt consists of 93% aggregate and 7% binding agent. In order to achieve the improved characteristics associated with enhanced asphalt, the standard binding agent would be replaced with the MatCon binding agent. Because it is standard construction practice to specify asphalt mixes, requiring the MatCon binding agent would be relatively straightforward. However, advanced planning would be required to ensure that the asphalt plant is capable of producing and transporting the enhanced asphalt to the site during periods of planned construction.

The enhanced asphalt cap would consist of one 4-inch compacted lift of standard aggregate and MatCon binding agent. The engineering design documents would specify the necessary methods for surface preparation, aggregate mix, and placement. The need for retainage ponds and maximum discharge velocity for stormwater runoff also would be addressed by either the removal design and/or the preliminary engineering design currently being conducted by Riverdale. Additionally, the engineering design documents would specify the fill placement for final drainage patterns.

Given that the Riverdale site is an active manufacturing facility which uses the existing on-site rail spurs as part of their raw material delivery system, placement of an enhanced asphalt cap beneath the spurs would be impractical. The weight of locomotives and tank cars would exert an extreme amount of pressure on the asphalt, and the cap would crack. Therefore, engineering design documents would specify that the cap extends up to rail ties and be graded to prevent surface water run-off from draining into the rail ballast.

While the existing limestone cover prevents direct contact with contaminated site soils, as an added level of precaution, air monitoring would be conducted during construction activities, when contaminated soils may be exposed and regraded, to ensure that workers and nearby residents are not exposed to site contaminants above allowable levels. Action levels would be established in the design documents to initiate engineering controls, such as dust suppression, or to stop work at individual work areas.

No removal and/or treatment of contaminated soils is proposed under this alternative; therefore, soils that exceed the target risk levels would be left on site. Institutional controls (deed restrictions) as described in Section 5.2.1 are incorporated as part of this alternative.

In addition to the costs associated with implementing the deed restrictions, the distinctive cost component for this alternative includes the installation of the enhanced asphalt cap and its associated maintenance. For the purposes of evaluating this alternative and estimating the associated costs, it is assumed that the cap would have to be placed over a 21,000-square-yard area (i.e., the existing area currently covered by limestone). The costs associated with maintaining the security fence surrounding the site and the security system currently in place are considered to be part of the normal cost of business associated with operating a production facility in Chicago Heights.

The time frame associated with the installation of the cap is estimated to be one month. For the purposes of this EE/CA, the PRSC was estimated over a 30-year period.

5.5 Alternative 4: Localized Hot Spot Removal and Install an Enhanced Asphalt Cap

While similar to Alternative 3, this alternative would include excavation and off-site disposal of soils posing a total cancer risk exceeding 1×10^{-4} and/or an HI greater than 1 as determined by the construction worker exposure scenario (see Figure 4-2).

Before installation of the enhanced asphalt cap as described in the previous alternative, soil exceeding a cumulative risk of 1×10^{-4} and/or an HI of greater than 1, using the construction worker scenario, would be excavated and shipped off site for disposal. Utilizing the risk-based contour maps developed for the construction worker scenario, and assuming an average soil contaminant thickness of 2.5 feet across the site, it is estimated that approximately 5,100 cubic yards of soil would have to be excavated and disposed of.

Prior to soil excavation, the existing limestone cover would be removed and stockpiled. The stockpiles would then be sampled and analyzed to determine whether contamination is present above the acceptable PRGs. For the purposes of developing the alternative, it was assumed that the limestone will be acceptable for use as backfill material.

As with the previous alternative, it has been assumed that the Riverdale's storm sewer upgrade will be compatible with the installation and operation of the enhanced asphalt cap. Therefore, this alternative also does not account for the need to upgrade the sewer tie-ins.

The engineering design documents would specify the necessary methods of excavation, excavation slopes, and/or use of structural supports (i.e., sheet piling) to maintain foundation integrity during soil removal activities near the facility buildings. Additionally, the documents would specify the fill placement for final drainage patterns and the necessary removal and replacement of the existing rail spurs for areas of excavation.

Limitations associated with placement of the cap beneath the rail spur for the previous alternative also apply to Alternative 4. The weight associated with rail traffic make it impractical to install a cap beneath the rails. Therefore, engineering design documents would specify that the cap extends up to rail ties and be graded to prevent surface water run-off from draining into the rail ballast.

Upon completion of excavation activities, the sidewalls and base of the excavation would be sampled and analyzed to determine compliance with the cleanup criteria. The sampling and analysis plan utilized during the removal action would be developed during the engineering design phase, and should be developed using U.S. EPA's guidance, "Methods for Evaluating the Attainment of Cleanup Standards" (U.S. EPA 1989c). For the purpose of developing the alternative for this EE/CA, it is assumed that 40 confirmation soil samples would be collected and submitted for analysis. The design documents should require that for each of the individual sample locations, a total risk and/or hazard index for all of the chemicals of concern would be calculated. Based on the level of risk and/or HI for the individual sample, a determination can be made as to whether the target risk level has been achieved. If the risk is determined to be above 10^{-4} or the HI is greater than 1 for the individual sample, compliance with the cleanup criteria will not have been met, and additional removal activities would have to be performed in that area.

Upon receipt of analytical data that verify compliance with the cleanup criteria, the open excavations would be backfilled with clean earthen material similar to site soils and obtained from a local borrow source. Engineering design documents would specify the necessary QC checks to ensure the type and cleanliness of backfill material. Additionally, for those soils beneath building foundations that contain contaminant levels above the cleanup objectives, before backfilling, a 20-mil HDPE liner would be placed over the soils to serve as a subsurface marker and barrier. The liner would prevent contaminants from leaching into the clean backfill and would provide a warning to future site workers regarding the potential of a hazardous waste work environment if excavation activities near the building foundation are performed.

Bennett
Bennett Environmental, Inc.

As discussed in Section 4.2.1, the excavated soil would be classified as a hazardous waste. The excavated material would be transported to a TSD facility that would incinerate the excavated soils. No United States TSD facility permitted to accept dioxin wastes has been identified. Therefore, it is assumed that the soils would be shipped to Bennett Environmental, Inc.'s, (Bennett) facility located in Vancouver, British Columbia, Canada for incineration. While no specific permit is required, engineering design documents would be developed to require the proper manifesting and methods of notification and shipment associated with transporting contaminated soil to Canada.

During construction activities, air monitoring would be conducted to ensure that workers and nearby residents are not exposed to site contaminants above allowable levels. Action levels would be established in the design documents to initiate engineering controls, such as dust suppression, or to stop work at individual work areas.

It is anticipated that soil beneath the facility buildings contains contaminant concentrations that exceed the target risk levels using either risk scenario. Institutional controls (i.e., deed restrictions) as described in Section 5.2.1 are a part of this alternative.

The time frame to complete this alternative is estimated to be 3 months. For the purposes of developing a cost estimate, it is assumed that approximately 5,100 cubic yards of soil would be excavated and transported to Bennett for incineration. Additionally, it is assumed that approximately 200 linear feet of rail spur would have to be removed and replaced to accommodate soil excavation.

5.6 Alternative 5: Excavation and Off-Site Incineration

This alternative would remove all accessible on-site surface soil and subsurface soil that exceed the target risk level for the Industrial Worker Scenario as determined using the data presented in the RI and SHHRE. Soil contamination beneath building foundations would be left in place.

Soil exceeding a risk of 10^{-4} and an HI equal to 1 would be excavated and shipped off site for incineration. Based on the findings of the RI, SHHRE, and contour mapping for the industrial worker exposure route, and assuming an average soil contaminant thickness of 2.5 feet across the site, it was estimated that approximately 10,900 cubic yards of soil would have to be excavated and incinerated. As with the previous alternative, it is assumed that the limestone will be suitable backfill material.

The engineering design documents would specify the necessary methods of excavation, excavation slopes, and/or use of structural supports (i.e., sheet piling) to maintain foundation integrity during soil removal activities near the facility buildings. Additionally, the engineering design documents would specify the final drainage patterns for fill placement and the necessary removal, disposal as a hazardous waste (as necessary), and replacement of the existing rail spurs to accommodate soil excavation.

Upon completion of excavation activities, the sidewalls and base of the excavation would be sampled and analyzed to determine compliance with the cleanup criteria. The sampling and analysis plan utilized during the removal action would be developed during the engineering design phase and should be developed using U.S. EPA's guidance, "Methods for Evaluating the Attainment of

Cleanup Standards" (U.S. EPA 1989c). For the development of this alternative, it is assumed that 62 confirmation soil samples would be collected and submitted for analysis. Whether compliance with the target risk levels has been achieved would be determined using the same methodology as presented for the previous alternative.

Upon receipt of analytical data that verify compliance with the cleanup criteria, the open excavations would be backfilled with clean earthen material similar to site soils and obtained from a local borrow source. Engineering design documents would specify the necessary QC checks to ensure the type and cleanliness of backfill material. Additionally, for those soils beneath building foundations that confirmation sampling shows noncompliance with the PRGs, before backfilling, a 20-mil HDPE liner would be placed between the contaminated soils and clean fill. The linear will serve as a subsurface marker and barrier preventing contaminants from leaching into the clean backfill and would provide a warning to future site workers regarding the potential of a hazardous waste work environment if excavation activities near the building foundation are performed.

As discussed in Section 4.2.1, the excavated soil would be classified as a hazardous waste. The excavated material would be transported to a TSD facility that would incinerate the excavated soils. Engineering design documents would be developed to require the proper manifesting and methods of shipment associated with transporting contaminated soil to Bennett's Canadian facility.

During construction activities, air monitoring would be conducted to ensure that workers and nearby residents are not exposed to site contaminants above allowable levels. Action levels would be established in the design documents to initiate engineering controls, such as dust suppression, or to stop work at individual work areas.

It is anticipated that soil beneath the facility buildings contains contaminant concentrations that exceed the target risk levels. Institutional controls (i.e., deed restrictions) as described in Section 5.2.1 have been included in this alternative.

The time frame to complete this alternative is estimated to be 3 months. For the purposes of developing a cost estimate, it is assumed that approximately 10,900 cubic yards of soil would be excavated and transported to Bennett Environmental, Inc.'s, facility for incineration. Additionally, it is assumed that approximately 325 linear feet of rail spur would have to be removed and replaced.

Table 5-1

COMMON COMPONENT COST
ECOLOGICAL SAMPLING
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
Direct Capital Costs					
Mobilize crew, 50 miles, per person	2	each	$56.25	1.083	$122
Biologist	50	hour	$60.00	1.000	$3,000
Field technician	50	hour	$50.00	1.000	$2,500
Lodging and per diem	8	day	$98.00	1.000	$784
Disposable materials per sample	17	sample	$7.96	1.083	$147
Decontamination materials per sample	17	sample	$9.23	1.083	$170
4-ounce sample jar, case of 24	1	each	$33.45	1.083	$36
Custody seals, package of ten	2	each	$14.72	1.083	$32
Overnight delivery 51-70 lb package	5	each	$50.00	1.083	$271
Analysis for pesticides (QA/QC samples included)	17	sample	$100.00	1.000	$1,700
Analysis for herbicides (QA/QC samples included)	17	sample	$100.00	1.000	$1,700
Analysis for dioxin (QA/QC samples included)	17	sample	$760.00	1.000	$12,920
Subtotal Direct Capital Costs					$23,382
Overhead and Profit (25%)					$5,846
Total Direct Capital Costs (Rounded to Nearest $1,000)					$29,000
Indirect Capital Costs					
Work plan preparation and reporting					$15,000
Legal Fees and License/Permit Costs (5%)					$1,450
Total Indirect Capital Costs (Rounded to Nearest $1,000)					$16,000
Subtotal Capital Costs					$45,000
Contingency Allowance (15%)					$6,750
Total Capital Costs (Rounded to Nearest 1,000)					**$52,000**

Key:
QA/QC = Quality Assurance/Quality Control
lb = pound

Table 5-2

COMMON COMPONENT COST
CONSTRUCT RAW MATERIAL STORAGE AREA
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
Direct Capital Costs					
Concrete ready mix (base)	417	cubic yard	$61	1.083	$27,526
Placing concrete (base)	417	cubic yard	$7	1.083	$3,159
Reinforcing in place, A615 Grade 60 (base)	30.7	ton	$935	1.083	$31,065
Form work (base)	600	linear feet	$2	1.083	$1,053
Concrete ready mix (wall)	67	cubic yard	$61	1.083	$4,434
Reinforcing in place, A615 Grade 60 (wall)	2.5	ton	$835	1.083	$2,234
Placing concrete (wall)	67	cubic yard	$12	1.083	$843
Form work (walls)	3612	sfca	$7	1.083	$25,935
Excavate pipe trench	59	cubic yard	$4	1.083	$264
Backfill pipe trench	59	cubic yard	$1	1.083	$89
2" diameter, acid-resistant pipe	200	linear feet	$10	1.083	$2,062
2" diameter, valve	1	each	$116	1.083	$126
Subtotal Direct Capital Costs					$98,790
Overhead and Profit (25%)					$24,698
Total Direct Capital Costs (Rounded to Nearest $1,000)					$123,000
Indirect Capital Costs					
Engineering and Design (7%)					$8,610
Legal Fees and License/Permit Costs (5%)					$6,150
Construction Oversight (15%)					$18,450
Total Indirect Capital Costs (Rounded to Nearest $1,000)					$33,000
Subtotal Capital Costs					$156,000
Contingency Allowance (15%)					$23,400
Total Capital Costs (Rounded to Nearest 1,000)					**$179,000**

Key:

sfca = square foot contact area

6 Detailed Analysis of Alternatives

The analysis of the identified removal action alternatives is a key element of the EE/CA, and provides the basis for selecting the most appropriate alternative. The individual alternatives described in Section 5 are evaluated in this section with regard to the short- and long-term aspects of the three broad criteria of effectiveness, implementability, and cost. These criteria are described in Section 300.430 in Paragraph (e)(9)(iii) of the NCP. Each criterion is defined below.

Effectiveness refers to the ability of an alternative to meet the objectives of the removal action scope. The effectiveness of the removal alternative is evaluated further based on five subcriteria:

- **Overall Protection of Human Health and the Environment**—Evaluation of the overall protectiveness of an alternative focused on the ability of the alternative to limit and/or reduce potential exposure to site contamination;

- **Compliance with ARARs**—This criterion is used to determine whether an alternative will meet identified federal, state, and local laws and regulations;

- **Long-Term Effectiveness and Permanence**—Alternatives are assessed for their long-term effectiveness and permanence along with the degree of certainty that the alternative will prove successful. Factors that are considered, as appropriate, include the magnitude of residual risk remaining from untreated waste and/or treatment residuals left on site at the conclusion of removal activities, and the adequacy and reliability of controls, such as containment systems and institutional actions, that are necessary to manage treatment residuals and untreated waste;

- **Reduction of Toxicity, Mobility, or Volume Through Treatment**—This criterion addresses U.S. EPA's regulatory preference for selecting removal actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of contaminants. This preference is satisfied when treatment is used to reduce the principal risk at a site through destruction of contaminants, reduction of the total mass of contaminants, irreversible reduction in mobility, or reduction of the total volume of a contaminated medium;

- **Short-Term Effectiveness**—The short-term impacts of alternatives are assessed considering the short-term risk that might be posed to the community during implementation of an alternative, potential impacts on workers during the removal action, and potential environmental impacts of the removal action.

Implementability evaluates the ability of the removal alternative to achieve a practical effect. The implementability evaluation is conducted by evaluating the alternative based on three subcriteria:

- **Technical Feasibility**—The alternatives are evaluated based on the maturity and reliability of the technology, the frequency and complexity of equipment maintenance and/or controls, the climate conditions affecting the alternatives, and the operation of PRSC measures;

- **Administrative Feasibility**—The level of effort necessary to coordinate removal alternative activities between U.S. EPA and other federal, state, and local government agencies is evaluated within this criterion. Statutory limits, permits, and waivers, and adherence to applicable non-environmental laws, also are factored into the evaluation; and

- **Availability of Services and Materials**—The alternatives are evaluated based on the ability to obtain the necessary labor, equipment, raw materials, and laboratory analysis required to implement, support, and sustain the alternatives.

For each alternative, an estimate of direct and indirect capital costs, as well as a long-term PRSC cost, is developed. Cost is a factor in comparing alternatives that can produce similar levels of protection for potential receptors. For removal action alternatives that are anticipated to last longer than 12 months, the present worth of the alternative is calculated (U.S. EPA 1993).

Two other criteria required by U.S. EPA, public acceptance and state acceptance, are not discussed specifically in this section but are applicable to the removal action selected for the Riverdale site.

These criteria will be evaluated after the comment period for this EE/CA is complete.

The removal action alternatives presented in this section are analyzed utilizing the best available information. Technical information was gathered from vendors, available U.S. EPA guidance documents, and on-line databases.

Because of the uncertainties associated with the estimated extent of contamination, the cost estimates presented in this section should not be considered final removal action costs. Instead, the estimates represent preliminary cost estimates either supplied by vendors working with a limited knowledge of the site-specific conditions, or obtained from the 1999 R.S. Means Co., Inc., cost estimating books (R.S. Means 1998). These estimates were used as a basis for comparing relative costs and evaluating technologies.

6.1 Alternative 1: No Action

The no-action alternative was evaluated to provide a baseline to which other alternatives can be compared, as required by the NCP. Under this alternative, contaminated soils would be left in their current condition, and no further maintenance of the limestone cover would be performed.

Effectiveness. While the existing limestone cover provides a protective barrier, without further maintenance, the barrier will deteriorate, and contaminants will be exposed for human contact and further migration. Therefore, protection of human health and the environment would not be provided by this alternative. Levels of contaminants and existing and future risk to human health and the environment would remain unchanged. Because media containing COPCs that exceed the target risk levels would be left on site without any PRSCs to maintain the barrier, the RAOs established for the Riverdale site would not be achieved. Additionally, deed restrictions to prevent residential use of the site would not be implemented, the on-site wetlands and off-site areas would not be investigated and remediated (if necessary), and stormwater would continue to come into contact with stored chemical containers and continue to run off into the wetlands. The no-action alternative would offer no long-term effectiveness or permanence. Finally, this alternative would provide no reduction in the toxicity, mobility, or volume of contaminants.

Implementability. This alternative is readily implementable because there are no technologies that would have to be implemented; administrative coordination would not be required; and there would be no labor, equipment, material, or laboratory services to be obtained.

Cost. There would be no costs associated with this alternative.

6.2 Alternative 2: Maintain Limestone Cover and Implement Institutional Controls

Under this alternative, the current limestone cover would be maintained and institutional controls would be implemented. As stated in Section 5.2, deed restrictions would be implemented to prevent future residential use of the site, an ecological site investigation would be performed, and a new bermed storage pad for raw chemical storage would be constructed as part of this alternative.

Effectiveness. The barrier included in this alternative would limit the potential for human exposure to contaminated soils and would be somewhat protective of human health and the environment. The limestone cover creates a limited physical barrier between potential receptors (i.e., the industrial worker) and the contaminated soil. However, the limestone barrier would not protect construction or utility workers engaged in intrusive activities (i.e., excavation) into the contaminated soil. Institutional controls, in addition to updating the site's hazard communication plan to identify the hazards of intrusive activities, as well as work rules that require that such activities only be performed under Hazardous Waste Operations and Emergency Response (HAZWOPER) procedures, and deed restrictions notifying potential buyers of the presence of subsurface soil contamination, can reduce the potential for exposure to soil contaminants. These measures may reduce exposure to soil contaminants in the short term; however, over time, plant personnel will change, administrative records may not be updated appropriately, and off-hour emergency situations requiring buried utilities repair will occur. All of these factors increase the potential that intrusive work at the Riverdale site may be performed by workers who are not properly trained and/or notified of the potential hazardous subsurface environment. Therefore, the effectiveness of institutional controls to be protective of human health is limited.

While creating a barrier, the limestone does allow stormwater to infiltrate into the subsurface soils, enabling contaminants to become mobile and to migrate horizontally and vertically, and potentially off site.

Under this alternative, COPC-contaminated soil exceeding the total cancer risk level of 1×10^{-4} and an HI of 1 would be left in place. As presented in Section 4, RCRA cap requirements are relevant and appropriate for the Riverdale site. Additionally, the presence of listed and/or characteristic hazardous waste at the site is likely, and has not been disproved. Therefore, a RCRA cap would be required. For this alternative, only 1 foot of crushed limestone would be maintained, so the ARAR associated with capping would not be met.

In order to maintain the thickness of the limestone cover, additional loads of limestone would have to be brought onto the site routinely. However, because contaminated soils would be left in place, there would be little long-term effectiveness and permanence achieved with this alternative. The limestone does reduce surface water infiltration into the contaminated soil, and thus there is some reduction in mobility; however, there is no reduction of toxicity or volume.

Because the current IRM would become the final action under this alternative, there would be no additional exposure to soil contamination, as long as current site activities remained constant. Therefore, this alternative would be effective in the short term.

Implementability. The limestone barrier has been implemented as an interim measure, with limestone being provided by a local quarry. Therefore, the alternative is technically feasible and services and materials are readily available. Implementation of deed restrictions and institutional controls is relatively straightforward. However, because the limestone barrier used in conjunction with institutional controls would not reduce potential exposure sufficiently, this alternative would not be administratively feasible.

Cost. There is no capital cost associated with Alternative 2. The annual PRSC cost is estimated to be $37,000, and the total present worth cost for this alternative is estimated to be $570,000, based on a 5% discount rate over 30 years. The details of this cost estimate are presented in Table 6-1. Additional information concerning the derived costs and basis for the estimated costs is provided in Appendix F. As stated in Section 5, the costs associated with implementing institutional controls (i.e., deed restrictions), sampling and analysis of off-site ecological habitats, and the construction of a raw materials storage area are not included in these costs. A total capital cost, including these common components, is provided in Section 8.

6.3 Alternative 3: Install Sitewide Enhanced Asphalt Cap

This alternative would involve grading and compacting the existing limestone cover, placing a 4-inch enhanced asphalt cap over the entire site, institutional controls, and PRSC measures. Riverdale personnel are designing an expanded sewer system to collect stormwater runoff. As stated in Section 5, the expanded on-site stormwater collection system would be a critical component of this alternative. Since Riverdale personnel are currently designing an upgrade of the existing stormwater collection system, it has been assumed that the upgrade can be engineered to be compatible with the cap proposed by this alternative. As stated in Section 5.2, deed restrictions would be implemented to prevent residential use of the site, an ecological site investigation would be performed, and a new bermed storage pad for raw chemical storage would be constructed as part of this alternative.

Effectiveness. The enhanced asphalt cap included in this alternative would limit the potential for human exposure to contaminated soil. The cap would create a physical barrier between potential receptors and the contaminated soil. It would be protective for general site workers and would reduce or eliminate further contaminant migration to ecologically sensitive areas on and adjacent to the site, but it would not be protective for construction/utility workers engaged in invasive activities. Deed restrictions notifying potential buyers of the presence of subsurface soil contamination provide limited protectiveness of human health and the environment. As discussed in Section 6.2, institutional controls could be difficult to maintain over long periods of time. By leaving contaminated soils that exceed a total cancer risk of 1×10^{-4} and an HI of 1 in place, there will always be the potential for construction worker exposure to soils exceeding the target risk levels. Therefore, there would be limited effectiveness associated with protection of human health.

The COPC-contaminated soil exceeding a target risk of 1×10^{-4} and/or an HI equal to 1 would be left in place. Because the enhanced asphalt cap could meet the performance requirements of a RCRA cap, the RCRA ARAR associated with capping would be met. The cap will be placed over the entire site. Therefore, TACO requirements associated with institutional controls would be met. Additionally, the limestone cover would provide an effective barrier preventing worker exposure to COPC-contaminated soil during installation of the cap. Finally, all capping work could be conducted in a manner that would comply with dust control and stormwater ARARs.

With regular maintenance, caps are considered effective for more than 30 years, thereby providing long-term effectiveness and permanence for the remaining on-site contamination. Although the cap would reduce exposure risks to site visitors and workers and would limit contaminant migration, soil contamination would remain on site.

Use of an enhanced asphalt can achieve a permeability of 1 x 10^{-8} cm/sec, which is less than traditional asphalt and crushed limestone. By achieving a RCRA standard of impermeability for a cap, the amount of stormwater infiltrating the subsurface soils will be reduced to a greater extent than would typically be achieved by standard asphalt and/or earthen materials. While capping does not reduce the toxicity or volume of on-site soil contamination, the enhanced asphalt will.

Because the limestone cover would be part of this alternative (i.e., it would provide the subbase for the asphalt cap), there would be limited potential for exposure to COPC contaminated soil during cap construction. By using dust suppression measures, short-term effectiveness could be obtained.

Implementability. The technology required to install an asphalt cap is reliable, and QC checks can be implemented readily to ensure that design specifications are met. Asphalt paving is an established procedure. Monitoring the effectiveness of the cap would be based on periodic visual inspections, so long-term PRSC for the cap would be a component of this alternative. Repair of the cap would be performed as necessary. A significant increase in truck traffic during cap construction has potential to cause traffic accidents, add to noise problems, and create dust. A traffic control plan would need to be developed to manage the flow of traffic. Additionally, standard construction permits and stormwater management plan approvals are routinely obtained as part of ordinary construction operations. Therefore, this alternative would be administratively feasible.

Cost. The total capital cost for Alternative 3 is estimated to be $953,000, and the annual PRSC cost is estimated to $24,000. The total present worth cost for this alternative is estimated to be $1,320,000, based on a 5% discount rate over 30 years. The details of this cost estimate are presented in Table 6-2. Additional information concerning the derived costs and basis for the estimated cost is provided in Appendix F. As stated in Section 5, the costs associated with instituting deed restrictions, sampling and analysis of on- and off-site ecological habitats, and construction of a new raw materials storage area are not included in these costs. A total capital cost, including these common components, is provided in Section 8.

6.4 Alternative 4: Localized Hot Spot Removal and Install an Enhanced Asphalt Cap

Under this alternative, surface and subsurface soils that exceed a total cancer risk of 1×10^{-4} and/or have an HI greater than 1 as determined for the construction worker scenario would be excavated and incinerated at an off-site TSD facility. Once the soil removal phase was completed, the excavations would be backfilled, and a protective enhanced asphalt cap would be placed over the entire site. As with Alternative 3, installation of an upgraded on-site stormwater collection system would be a critical component. Since Riverdale personnel are currently designing an upgrade of the existing stormwater collection system, it has been assumed that the upgrade can be engineered to be compatible with the cap proposed by this alternative. As stated in Section 5.2, deed restrictions would be implemented to prevent residential use of the site, an ecological site investigation would be performed, and a new bermed storage pad for raw chemical storage would be constructed as part of this alternative.

Effectiveness. This alternative would protect human health and the environment by removing surface and subsurface soils that exceed a total cancer risk of 1×10^{-4} or an HI of 1 for the construction worker scenario. Furthermore, the enhanced asphalt cap would create a physical barrier between potential receptors and the contaminated soil that is left in place, which, for the industrial worker, would still exceed a total cancer risk level of 1×10^{-4} at several locations on site. Industrial workers are not assumed to engage in intrusive activities, therefore, the placement of the cap would be protective of human health and the environment.

Because the enhanced asphalt cap could meet the performance requirements of a RCRA cap, this ARAR would be met. While TACO Tier 1 cleanup objectives would not be met, TACO does allow for the use of institutional controls (i.e., capping). Because the proposed enhanced asphalt cap would cover the entire site, this TBC also would be met.

Additionally, all asphalt cap work could be conducted in a manner that would comply with dust control and stormwater ARARs. Because soil exceeding a 10^{-4} risk or an HI greater than 1 for the construction worker scenario would be excavated and transported to an off-site incinerator, reduction in the toxicity, mobility, and volume would be achieved.

During excavation activities, on-site removal workers and nearby residents could be exposed to contaminants through direct contact with contaminated materials or inhalation of generated dust. Such exposure could be minimized through the use of protective clothing and equipment, as well as dust suppression measures. During excavation operations, there would be increased potential for erosion of contaminated soils and transport of these materials off site. To prevent this from occurring and to provide short-term effectiveness, stormwater management and dust suppression controls would be implemented.

Implementability. Alternative 4 would be technically feasible, with equipment, labor, and disposal facilities readily available. Fill material could be obtained from a local borrow source, and an asphalt plant is located in nearby Whiting, Indiana. The binding agent, which is the critical component of the enhanced asphalt system, is readily available and has been supplied to the Chicago area. As stated in Section 5, an enhanced asphalt cap has been installed at a site located in Elgin, Illinois. Additionally, paving of large surface areas is an established construction component. Dedicated equipment and skilled laborers are readily available. Finally, routine PRSC measures would include maintenance of the enhanced asphalt. Based on vendor contacts, the practice of maintaining asphalt is established as well. The enhanced asphalt is also more durable and has better wear resistance than does conventional asphalt. Therefore, less maintenance is required. Based on the availability of products, equipment, experienced laborers, and the need for fewer PRSC measures, an enhanced asphalt cap is implementable.

An increase in truck traffic through Chicago Heights would occur during implementation of this alternative as a result of hauling soil waste from the site to the incinerator and hauling fill and asphalt to the site. The additional traffic could result in increased accidents, add to noise problems, and create dust. Also, transportation of hazardous waste over public roads would be a concern because of the risk of accidents with potential for spills and leaks of waste. Therefore, a control plan would have to be developed to manage the flow of traffic as well as a response plan to address an accidental release. Standard construction permits and approvals for stormwater management would be required. While these permits are readily available, special manifesting would be required to ship hazardous waste to Canada. In order to manifest the waste shipments to Canada, the United States and Canadian governments must grant approval. U.S. EPA already has shipped dioxin-contaminated soil to Canada as part of the removal action undertaken at the Saunders Supply Company site located in Chuckatuck, Virginia. Because precedents exist, shipping a hazardous waste to Canada would be administratively feasible.

Cost. The total capital cost for Alternative 4 is estimated to be $4,630,000, and the annual PRSC cost is estimated to be $24,000. The total present worth cost for this alternative is estimated to be $5,000,000, based on an 5% discount rate over 30 years. The details of this cost estimate are presented in Table 6-3. Additional information concerning the derived costs and basis for the estimated cost is provided in Appendix F. As stated in Section 5, the costs associated with instituting deed restrictions, sampling and analysis of on- and off-site ecological habitats, and the construction of a new raw materials storage area are not included in these costs. A total capital cost, including these common components, is provided in Section 8.

6.5 Alternative 5: Excavation and Off-Site Incineration

For this alternative, surface soil and subsurface soil that exceed a risk of 1×10^{-4} and/or an HI of 1 would be excavated and incinerated at a TSD facility in Canada. Because contaminated soil beneath site structures would be left in place, there is potential for soils that do not meet the established target risks to be left on site. Therefore, deed restrictions preventing future residential land use would be required. As with all of the action alternatives, an ecological site investigation and construction of a new chemical storage area also would be required.

For all open areas of the site, soils and the existing limestone cap would be excavated to 3.5 feet BGS. It is anticipated that most of the 1-foot-thick limestone cap would not be classified as a hazardous waste. Therefore, it is assumed that soil, mainly from the 1- to 3.5-foot-BGS interval, would be shipped off site for incineration. Confirmation soil sampling and analysis would be performed before backfilling operations to ensure compliance with the established cleanup criteria. Once backfilling operations are complete, the site would be regraded.

Effectiveness. This alternative would protect human health and the environment by removing all contaminated surface and subsurface soil exceeding a risk of 1×10^{-4} and/or having an HI greater than 1 for industrial workers.

There is the potential for contaminated soil exceeding a total cancer risk of 10^{-4} to be present beneath current site structures. The existing building foundations and an HDPE liner placed between potentially contaminated soil and clean backfill could limit potential exposure.

During soil excavation, hauling, and backfilling operations, on-site removal workers and nearby residents could be exposed to contaminants through direct contact with waste materials or inhalation of generated dust. Such exposure could be minimized by the use of protective clothing and equipment and dust suppression measures. Transportation of hazardous waste over public roads would be a concern because of the risk of accidents with potential for spills and leaks of waste. Therefore, a control plan would have to be developed to manage response measures to address accidental releases.

Implementability. Alternative 5 would be technically feasible, with equipment, labor, and disposal facilities available. Fill material could be obtained from a local borrow source. An increase in truck traffic through Chicago Heights would occur during implementation of this alternative as a result of hauling waste from the site to the incinerator and hauling fill and asphalt to the site. The additional traffic could result in increased accidents, add to noise problems, and create dust. A traffic control plan would have to be developed to manage the flow of traffic. Standard construction permits and approvals for stormwater management would be required. As with Alternative 4, special consideration would be given to shipping a listed hazardous waste to Canada. As previously stated, U.S. EPA already has set precedents by shipping a listed hazardous waste to Canada. Therefore, this alternative would be administratively feasible.

Cost. The total capital cost for Alternative 5 is estimated to be $7,260,000, and there is no annual PRSC cost associated with this alternative. Therefore, the total present worth cost for this alternative is estimated to be $7,260,000. The details of this cost estimate are presented in Table 6-4. Additional information concerning the derived costs and basis for the estimated cost is provided in Appendix F. As stated in Section 5, the costs associated with instituting deed restrictions, sampling and analysis of on- and off-site ecological habitats, and the construction of a new raw materials storage area are not included in these costs. A total capital cost, including these common components, is provided in Section 8.

Table 6-1

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 2
MAINTAIN LIMESTONE COVER AND INSTITUTIONAL CONTROLS
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
Direct Capital Costs					
None					$0
Indirect Capital Costs					
None					$0
Total Capital Costs (Rounded to Nearest $100)					**$0**
Annual PRSC Costs					
Cover Maintenance (includes grading)	1,750	cubic yards	$11	1.000	$19,250
Yearly Summary Report/Cover Inspection	1	lump sum	$4,573	1.083	$4,953
Subtotal Direct PRSC Costs (Rounded to Nearest $1,000)					$24,000
Indirect PRSC Costs					
Overhead and Profit (25%)					$6,000
Administration (5%)					$1,200
Insurance, Taxes, Licenses (2.5%)					$600
Subtotal Indirect PRSC Costs					$7,800
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest $1,000)					$32,000
Contingency Allowance (15%)					$4,800
Total Annual PRSC Cost (Rounded to the nearest $1,000)					**$37,000**

30-Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	$0
Present Worth of 30 years PRSC (Rounded to Nearest $1,000)	$569,000
Total Alternative Cost (Rounded to Nearest $10,000)	**$570,000**

Key:

PRSC = Post-removal site control

Table 6-2

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 3
INSTALL SITEWIDE ENHANCED ASPHALT CAP
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
Direct Capital Costs					
Field Overhead and Oversight	1	month	$1,502	1.083	$1,627
Health and Safety	1	month	$12,887	1.000	$12,887
Mobilization and Demobilization of Site Equipment	1	lump sum	$3,368	1.083	$3,648
Air Monitoring	1	month	$4,176	1.083	$4,523
Add Limestone to establish final Grade (Includes Transportation)	7,000	cubic yard	$10	1.000	$71,925
Fine Grade (Large Area)	21,000	square yard	$0.49	1.083	$11,144
Asphalt Cap	21,000	square yard	$7.04	1.000	$147,840
Mattoon Binder	21,000	square yard	$12.80	1.000	$268,800
Subtotal Direct Capital Costs					$522,394
Overhead and Profit (25%)					$130,599
Total Direct Capital Costs (Rounded to Nearest $1,000)					$653,000
Indirect Capital Costs					
Engineering and Design (7%)					$45,710
Legal Fees and License/Permit Costs (5%)					$32,650
Construction Oversight (15%)					$97,950
Total Indirect Capital Costs (Rounded to Nearest $1,000)					$176,000
Subtotal Capital Costs					$829,000
Contingency Allowance (15%)					$124,350
Total Capital Costs (Rounded to Nearest $1,000)					$953,000
Annual PRSC Costs					
Asphalt Cover Maintenance (2.5% surface area needs yearly maintenance)	525	square yard	$8	1.083	$4,554
MatCon Binder	525	square yard	$13	1.000	$6,720
Yearly Summary Report/Cover Inspection	1	lump sum	$4,573	1.000	$4,573
Subtotal Direct PRSC Costs (Rounded to Nearest $1,000)					$16,000
Indirect PRSC Costs					
Overhead and Profit (25%)					$4,000
Administration (5%)					$800
Insurance, Taxes, Licenses (2.5%)					$400
Subtotal Indirect PRSC Costs					$5,200
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest $1,000)					$21,000
Contingency Allowance (15%)					$3,150
Total Annual PRSC Cost (Rounded to the nearest $1,000)					$24,000

30-Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	$953,000
Present Worth of 30 years PRSC (Rounded to Nearest $1,000)	$369,000
Total Alternative Cost (Rounded to Nearest $10,000)	**$1,320,000**

Key:

PRSC = Post-removal site control.

Table 6-3

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 4
LOCALIZED HOT SPOT REMOVAL AND INSTALL AN ENHANCED ASPHALT CAP
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
Direct Capital Costs					
Field Overhead and Oversight	3	month	$1,502	1.083	$4,880
Health and Safety	2	month	$12,887	1.083	$27,913
Mobilization and Demobilization of Site Equipment	1	lump sum	$3,368	1.083	$3,648
Air Monitoring	2	month	$4,176	1.083	$9,045
Decontamination Pad	1	lump sum	$6,964	1.083	$7,542
Remove and Replace Rail Spur	200	linear foot	$26.38	1.083	$5,714
Removal of Limestone Cover	2,041	cubic yard	$0.82	1.083	$1,812
Excavate Contaminated Soil (Assume direct load into trucks)	5,100	cubic yard	$1.50	1.083	$8,285
Soil Disposal Characterization	35	each	$960	1.000	$33,600
Transportation and Incineration of Contaminated Soils	5,100	cubic yard	$361	1.000	$1,841,100
Confirmation Sampling	40	each	$1,177	1.000	$47,080
40-mil HDPE Liner	2,000	square feet	$1.16	1.083	$2,513
Borrow (buy and load at pit, haul 2 miles)	5,100	cubic yard	$7.73	1.083	$42,695
Compaction	7,141	cubic yard	$0.67	1.083	$5,181
Add Limestone to establish final Grade (Includes Transportation)	7,000	cubic yard	$10	1.000	$68,835
Fine Grade (Large Area)	21,000	square yard	$0.49	1.083	$11,144
Asphalt Cap	21,000	square yard	$7.04	1.000	$147,840
MatCon Binder	21,000	square yard	$12.80	1.000	$268,800
Subtotal Direct Capital Costs					$2,537,627
Overhead and Profit (25%)					$634,407
Total Direct Capital Costs (Rounded to Nearest $1,000)					$3,172,000
[illegible]					
Engineering and Design (7%)					$222,040
Legal Fees and License/Permit Costs (5%)					$158,600
Construction Oversight (15%)					$475,800
Total Indirect Capital Costs (Rounded to Nearest $1,000)					$856,000
Subtotal Capital Costs					$4,028,000
Contingency Allowance (15%)					$604,200
Total Capital Costs (Rounded to Nearest $1,000)					**$4,632,000**
Annual PRSC Costs					
Asphalt Cover Maintenance (assumes 2.5% surface area needs yearly maintenance)	525	square yard	$8	1.083	$4,554
MatCon Binder	525	square yard	$13	1.000	$6,720
Yearly Summary Report/Cover Inspection	1	lump sum	$4,573	1.000	$4,573
Subtotal Direct PRSC Costs (Rounded to Nearest $1,000)					$16,000
Indirect PRSC Costs					
Overhead and Profit (25%)					$4,000
Administration (5%)					$800
Insurance, Taxes, Licenses (2.5%)					$400
Subtotal Indirect PRSC Costs					$5,200
Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest $1,000)					$21,000
Contingency Allowance (15%)					$3,150
Total Annual PRSC Cost (Rounded to the nearest $1,000)					**$24,000**

30-Year Cost Projection (Assumed discount rate per year: [illegible]%)	
Total Capital Costs	$4,632,000
Present Worth of 30 years PRSC (Rounded to Nearest $1,000)	$369,000
Total Alternative Cost (Rounded to Nearest $10,000)	**$5,000,000**

Key:

HDPE =High-density polyethylene

PRSC = Post-removal site control

Table 6-4

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 5
EXCAVATION AND OFF-SITE INCINERATION
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS**

Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
Direct Capital Costs					
Field Overhead and Oversight	4	month	$1,502	1.083	$6,507
Health and Safety	3	month	$12,887	1.083	$41,870
Mobilization and Demobilization of Site Equipment	1	lump sum	$3,368	1.083	$3,648
Air Monitoring	3	month	$4,176	1.083	$13,568
Decontamination Pad	1	lump sum	$6,964	1.083	$7,542
Remove and Replace Rail Spur	325	linear foot	$26.38	1.083	$9,285
Removal of Limestone Cover	4,360	cubic yard	$0.82	1.083	$3,872
Excavate Contaminated Soil (Assume direct load into trucks)	10,900	cubic yard	$1.50	1.083	$17,707
Soil Disposal Characterization	28	each	$800	1.000	$22,400
Transportation and Incineration of Contaminated Soils	10,900	cubic yard	$361	1.000	$3,934,900
Confirmation Sampling	62	each	$1,177	1.000	$72,974
40-mil HDPE Liner	3,320	square feet	$1.16	1.083	$4,171
Borrow (buy and load at pit, haul 2 miles)	10,900	cubic yard	$7.73	1.083	$91,250
Compaction	10,900	cubic yard	$0.67	1.083	$7,909
Fine Grade (Large Area)	13,018	square yard	$0.49	1.083	$6,908
Subtotal Direct Capital Costs					$4,244,511
Overhead and Profit (25%)					$1,061,128
Total Direct Capital Costs (Rounded to Nearest $1,000)					$5,306,000
Indirect Capital Costs					
Engineering and Design (3%)					$159,180
Legal Fees, Implement Institutional Controls, License/Permit Costs (5%)					$50,000
Construction Oversight (15%)					$795,900
Total Indirect Capital Costs (Rounded to Nearest $1,000)					$1,005,000
Subtotal Capital Costs					$6,311,000
Contingency Allowance (15%)					$946,650
Total Alternative Cost (Rounded to Nearest $10,000)					**$7,260,000**

Key:
HDPE = High-density polyethylene.

7 Comparative Analysis of Alternatives

In this section, a comparative analysis is presented to evaluate the relative performance of each of the five removal action alternatives in relation to U.S. EPA's three broad criteria of effectiveness, implementability, and cost. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to the others so that key trade-offs that may affect the selection of a removal action alternative can be identified.

RPM
Remedial Project Manager

As discussed with U.S. EPA's Remedial Project Manager (RPM), the alternatives under consideration for the Riverdale site are as follows:

- Alternative 1: No Action;
- Alternative 2: Maintain Limestone Cover and Implement Institutional Controls;
- Alternative 3: Install Sitewide Enhanced Asphalt Cap;
- Alternative 4: Localized Hot Spot Removal and Install An Enhanced Asphalt Cap; and
- Alternative 5: Excavation and Off-Site Incineration.

In order to properly evaluate the removal alternatives against one another, it is assumed that for Alternatives 3 and 4, Riverdale would upgrade its stormwater collection system, and that the upgrade would be compatible with their proposed caps. Additionally, it is assumed that the common action item components (i.e., ecological sampling and analysis and construction of a new protective raw chemical storage area) would be implemented.

In Section 6, the individual removal action alternatives are evaluated independently against the three broad criteria of effectiveness, implementability, and cost. Additionally, the advantages and disadvantages of the individual removal alternatives are identified. This evaluation provides the basis for the comparative analysis of the removal action alternatives presented below.

7.1 Effectiveness Evaluation

Except for Alternative 1, all alternatives would provide some level of protection for human health and the environment. Alternative 4 would be the most protective because all soil exceeding a total cancer risk of 1×10^{-4} or having an HI greater than 1 for the construction worker exposure scenario would be removed from the site, and all remaining soil would be contained with an enhanced barrier. While Alternative 5 removes a greater amount of contaminated soil from the site, soil exceeding a total cancer risk of 1×10^{-5} would remain on site without being capped. Alternatives 3 and 4 would provide a similar level of protection in that they would involve containment of the contaminated media. However, Alternative 4 would be more protective for construction workers by excavating and removing the site soils exceeding a cancer risk of 1×10^{-4} or an HI of 1. Therefore, Alternative 4 would provide a greater level of protection. Finally, Alternative 2 would provide the lowest level of protection among the action alternatives, because no modification to the existing limestone cover would be made.

Regardless of the alternative selected, some volume of soil exceeding the established PRGs for the site would remain in place. Alternative 5 leaves the least amount of contaminated soil on site. Of the action alternatives that involve containment (Alternatives 2, 3, and 4), Alternatives 3 and 4 would meet the ARARs associated with RCRA capping. Because Alternative 2 would use only 1 foot of earthen material (i.e., limestone) this alternative would not meet these ARARs. Except for the no-action alternative and Alternative 2, all of the alternatives could be implemented in a manner that would comply with RCRA hazardous waste shipping, dust control, and stormwater management ARARs.

Alternative 1 would offer no long-term effectiveness or permanence. While Alternative 5 removes the most contaminated soil from the site, Alternative 4 would be the most effective in reducing long-term human exposure to contaminants for the Riverdale site by removing the highest-risk soil from the site and capping the remaining soil contamination. While Alternatives 3 and 4 would provide a suitable cap to prevent exposure to soils exceeding the target risk levels, Alternative 4 would provide better long-term effectiveness by removing soils that a construction worker could be exposed to, that have a cancer risk exceeding 1×10^{-4} or an HI greater than 1. Alternative 2 would provide the least long-term effective remedy among the four action alternatives.

While Alternatives 4 and 5 would reduce toxicity, mobility, and volume, Alternative 5 would provide for greater reduction in toxicity and volume because more contaminated soil would be removed and incinerated. Alternative 4 does provide for a greater reduction in mobility than does Alternative 5, because an enhanced asphalt cap will be used to reduce stormwater infiltration in areas, which still have soil contamination above a total cancer risk of 1×10^{-5}. Although reduction of toxicity, mobility, and/or volume would not be achieved through treatment in any of the remaining alternatives, except for the no-action alternative, the remaining alternatives would provide some level of reduction in mobility of on-site contamination. Alternative 3 would provide greater reduction in mobility than Alternative 2, because the enhanced asphalt cap would be less permeable than the limestone cover presented in Alternative 2. Additionally, because the limestone cover would be more permeable than the underlying soils, there would be potential for stormwater infiltration to come into contact with the contaminated soil, increasing contaminant mobility.

In terms of short-term effectiveness, Alternative 1 (no-action) would pose no short-term threat to workers or nearby residents; however, this alternative would not be protective of human health and the environment. The potential impacts from increased truck traffic and soil removal and placement operations inherent in the implementation of the remaining alternatives would pose some short-term threats. Because Alternatives 4 and 5 would involve excavation, removal, and hauling of contaminated site soil, these alternatives would pose a potentially greater short-term risk to workers and nearby residents than Alternatives 2 and 3, which would involve placement of clean materials on the surface of an established barrier. Because Alternative 5 would remove more soil, it would pose a greater short-term risk than Alternative 4. While Alternatives 2 and 3 would involve working with a barrier to soil contamination already in place, Alternative 3 would pose more of a short-term risk because asphalt would be trucked to the site, whereas Alternative 2 would bring only limestone.

Appropriate dust control measures, which would minimize dust generated during the implementation of these alternatives, and traffic control measures could be implemented readily.

Except for the no-action alternative, the time required to implement any removal action alternative would range from one month to 3 months. Alternative 2 would require the least time (approximately one month) and Alternative 5 would require the most time (approximately 3 months). The remaining alternatives would fall within this range. In addition to the time required to implement the removal action alternative, Alternatives 2, 3, 4, and 5 would incorporate PRSC measures. However, only Alternatives 2, 3, and 4 would involve PRSC measures associated with maintaining a cap. Because only maintaining deed restrictions is proposed, Alternative 5 would require the least amount of PRSC. For the purposes of this EE/CA, it is assumed that PRSC measures for Alternatives 2, 3, and 4 would be conducted regularly for approximately 30 years.

7.2 Implementability Evaluation

Because there would be no action associated with it, Alternative 1 would be the easiest alternative to implement. All remaining alternatives would utilize mature, proven technologies. For alternatives that would involve off-site incineration, a site located in Canada (Bennett Environmental, Inc. [Griffiths 1999]) has indicated that it has the permits and sufficient space and capacity to receive and incinerate site soils containing contamination above the established RBCs. Common materials, labor, and equipment should be readily available for the implementation of excavation and/or capping activities.

Except for Alternative 1, Alternative 2 would be the most readily implementable alternative. Alternative 2, which is the current IRM, would be maintained at its current level. Alternative 5, which would involve extensive excavation and incineration of contaminated soils, would be the most difficult to implement. While Alternatives 3 and 4 are similar, Alternative 3 would be more readily implementable, because soil excavation would not be included.

Administratively, Alternative 3 would be implemented more easily than the other alternatives. Because Alternatives 4 and 5 would involve transporting a listed hazardous waste to Canada, special permitting, which has been obtained, would be required. Alternative 2 would not be administratively feasible, because potentially hazardous waste would remain on site.

7.3 Cost Evaluation

Cost estimates were presented based on current market prices as quoted by applicable vendors, and on price ranges quoted in recent literature. All costs were rounded to the nearest $10,000. The estimated costs including, capital and PRSC, if applicable, to implement the various alternatives at the Riverdale site are estimated as follows:

- Alternative 1: $ 0,
- Alternative 2: $570,000,
- Alternative 3: $1,320,000,
- Alternative 4: $5,000,000, and
- Alternative 5: $7,260,000.

Excluding Alternative 1, the low-end cost would be for maintaining the current limestone cover. The high-end cost would be for the sitewide removal and off-site incineration. The mid-range costs would be for Alternatives 3 and 4, which would involve placement of an enhanced asphalt cap. The mid-range costs for Alternative 4 would be more because of the excavation and off-site incineration component.

The estimated extent of soil contamination and corresponding volume calculations were based on the findings of the RI. Confirmation sampling would be conducted as part of alternatives requiring excavation activities to confirm that target risk levels are met. However, the sampling may indicate that additional areas not identified by the RI would have to be excavated and disposed of in order to meet the cleanup criteria, thereby resulting in an increase in the estimated costs for these alternatives.

8 Proposed Sitewide Removal Action Alternative

Based on the alternative evaluation in Section 7, a removal action alternative is proposed in this section. In order to address soil contamination and to be protective of human health and the environment in a cost-effective manner, Alternative 4 (Localized Hot Spot Removal and Install an Enhanced Asphalt Cap) is the recommended alternative. While not removing as much of the soil contamination as proposed in Alternative 5, Alternative 4 would remove the areas of highest risks to current and future construction workers and would provide a sitewide protective barrier for the industrial worker. Additionally, Alternative 4 would provide a better protective barrier from an ecological standpoint than does the existing limestone cover proposed in Alternative 2.

Also included in the recommended sitewide removal action are the common action item components. Deed restrictions must be implemented to prevent future residential use of the site. Ecological sampling and analysis of the adjacent wetlands and off-site areas must be performed to ensure that any contamination present is not adversely affecting valuable ecological resources. Additionally, raw materials stored outside must be placed ir ın area that will prevent spills and/or stormwater contact and runoff from entering the subsurface and the wetlands located southeast of the industrial portion of the facility. These three common components are to be included in the sitewide removal action alternative.

As discussed in Sections 5 and 6, it is assumed that Riverdale will upgrade its existing stormwater collection system. While it has been assumed that the sewer system will be upgraded and will be compatible with the enhanced asphalt cap, if the existing sewer system is not upgraded, Alternative 4 would have to be modified to include redesign and construction of a new system. The enhanced asphalt cap would increase the amount of surface water runoff at the site because it would be less permeable than the existing limestone cover. If not properly drained, the increase in volume may cause operational problems at the facility and potentially increase the amount of surface water runoff to the surrounding ecological habitats. Surface water runoff from any industrial facility has the potential to adversely affect surrounding habitats, and by increasing the runoff, there is an increase in the potential effects. Therefore, upgrading the existing stormwater sewers would be a necessary component of the selected sitewide removal action alternative.

Individual cost estimates were prepared for each removal alternative and common action item components. Utilizing the individual cost estimates, a cost for implementing a comprehensive sitewide removal action alternative was prepared. The estimated cost for the sitewide removal action is $5,235,000. Table 8-1 presents a breakdown of the associated costs.

Table 8-1

SITEWIDE REMOVAL ACTION--COST ESTIMATES
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Alternative Number	Alternative Name	Capital Costs	Present Worth of PRSC Costs	Institutional Controls	Ecological Sampling	Raw Material Storage Area	Estimated Total Present Worth Cost
1	No Action	$0	$0	$2,500	$0	$0	$0
2	Maintain Limestone Cover and Implement Institutional Controls	$0	$569,000	$2,500	$52,000	$179,000	$803,000
3	Install Sitewide Enhanced Asphalt Cap	$953,000	$369,000	$2,500	$52,000	$179,000	$1,556,000
4	Localized Hot Spot Removal And Install an Enhanced Asphalt Cap	$4,632,000	$369,000	$2,500	$52,000	$179,000	$5,235,000
5	Excavation and Off-Site Incineration	$7,260,000	$0	$2,500	$52,000	$179,000	$7,494,000

Key:

PRSC = Post-removal site control.

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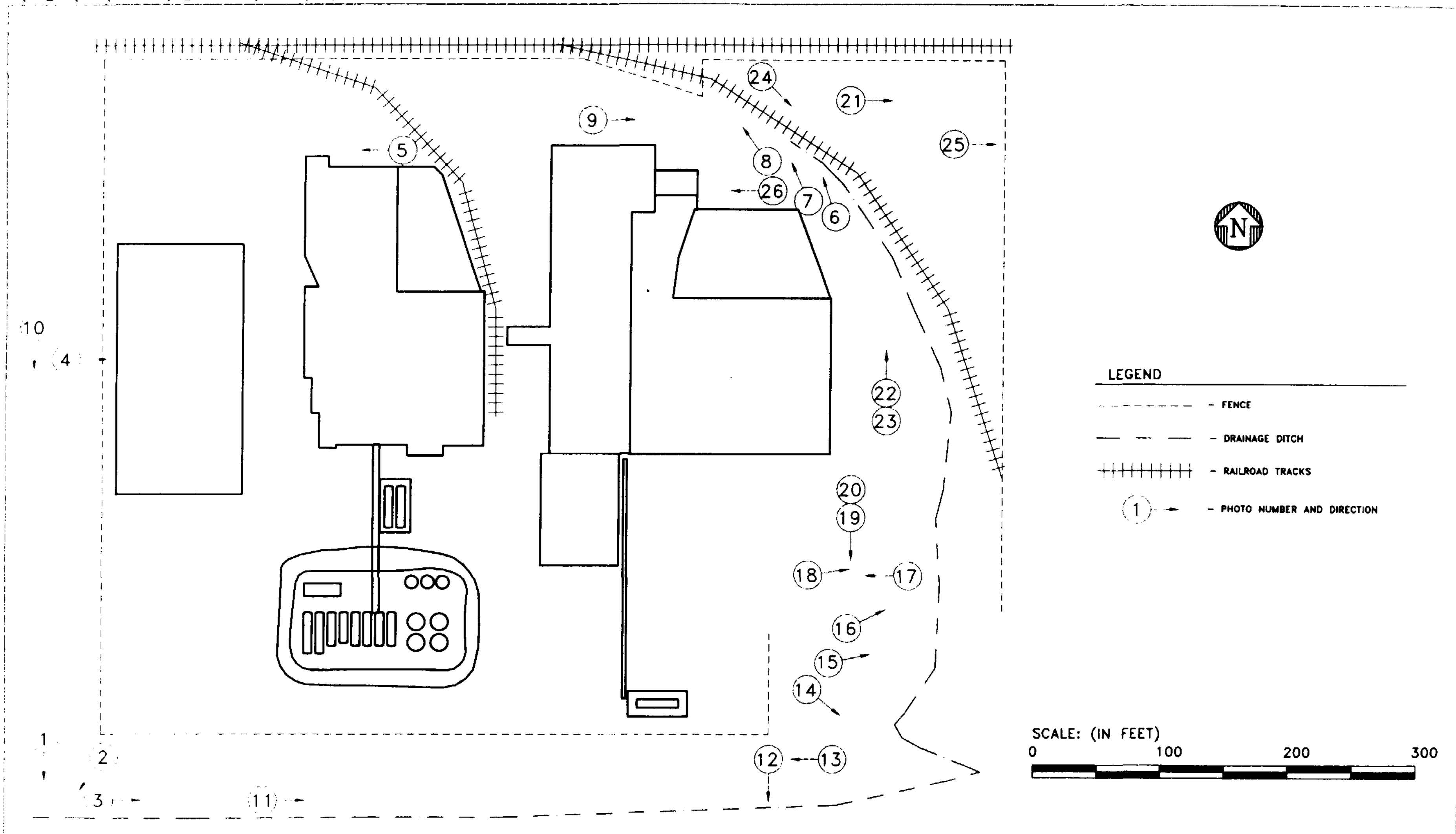
A

Ecological Survey Field Reconnaissance Photo Log

H:\ACD_FLS\KJ05\RIVERDALE\RD_PHOTOS.DWG/29FEB00/RES/CHICAGO,IL.



ecology and environment

FIGURE A-1 PHOTOGRAPH LOCATIONS AND DIRECTIONS
RIVERDALE CHEMICAL CO.
CHICAGO HTS., IL.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: **Riverdale Chemical Company**

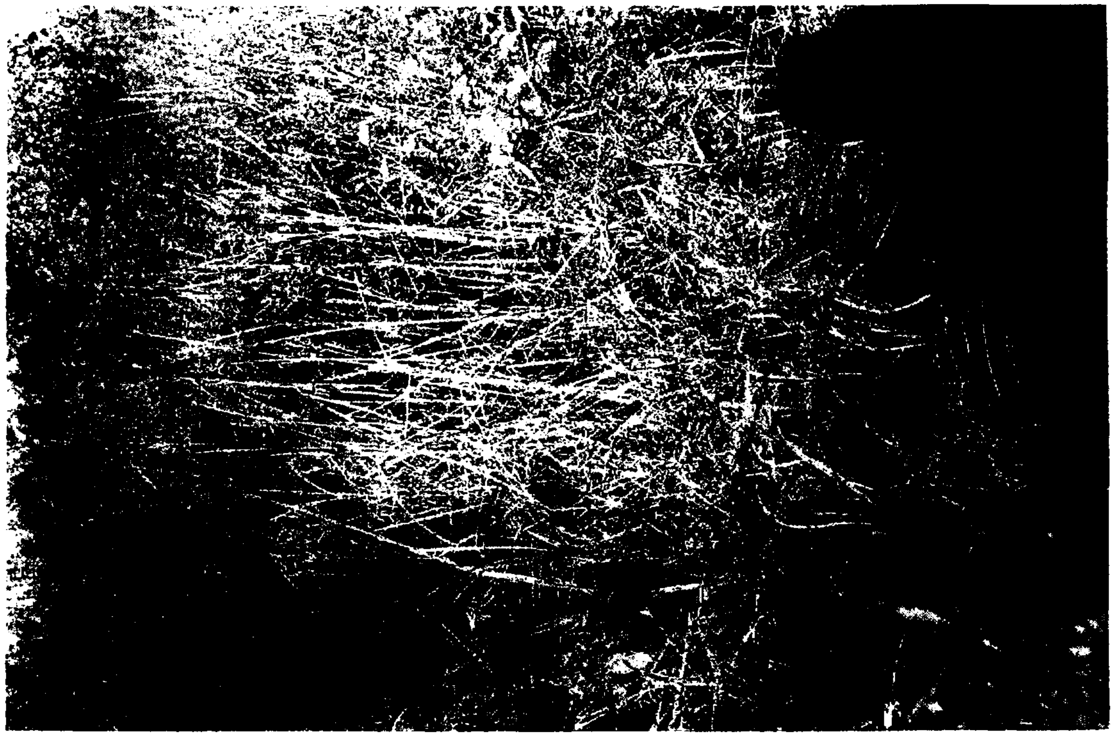
JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER:
1

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH:
South

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View of cattails adjacent to the drainage ditch off site.

PHOTO NUMBER:
2

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH:
Southwest

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: Farther back view of cattails adjacent to drainage ditch off site.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: Riverdale Chemical Company

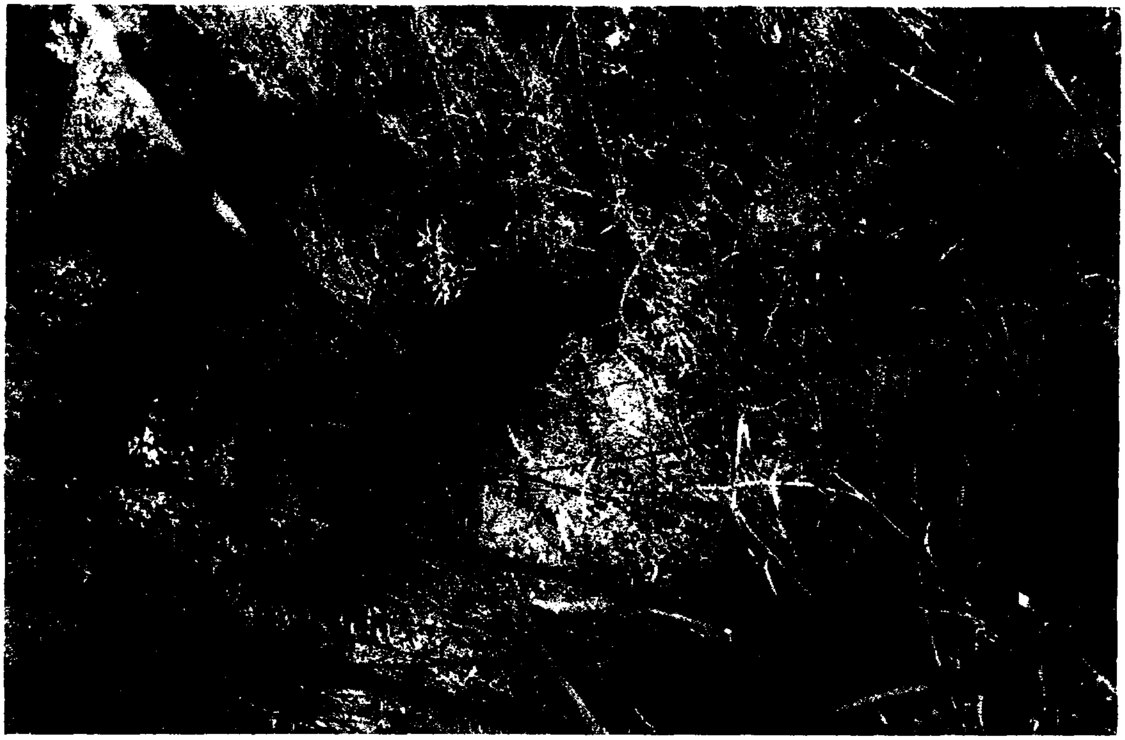
JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 3

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: East

PHOTOGRAPHED BY: Anne Busher



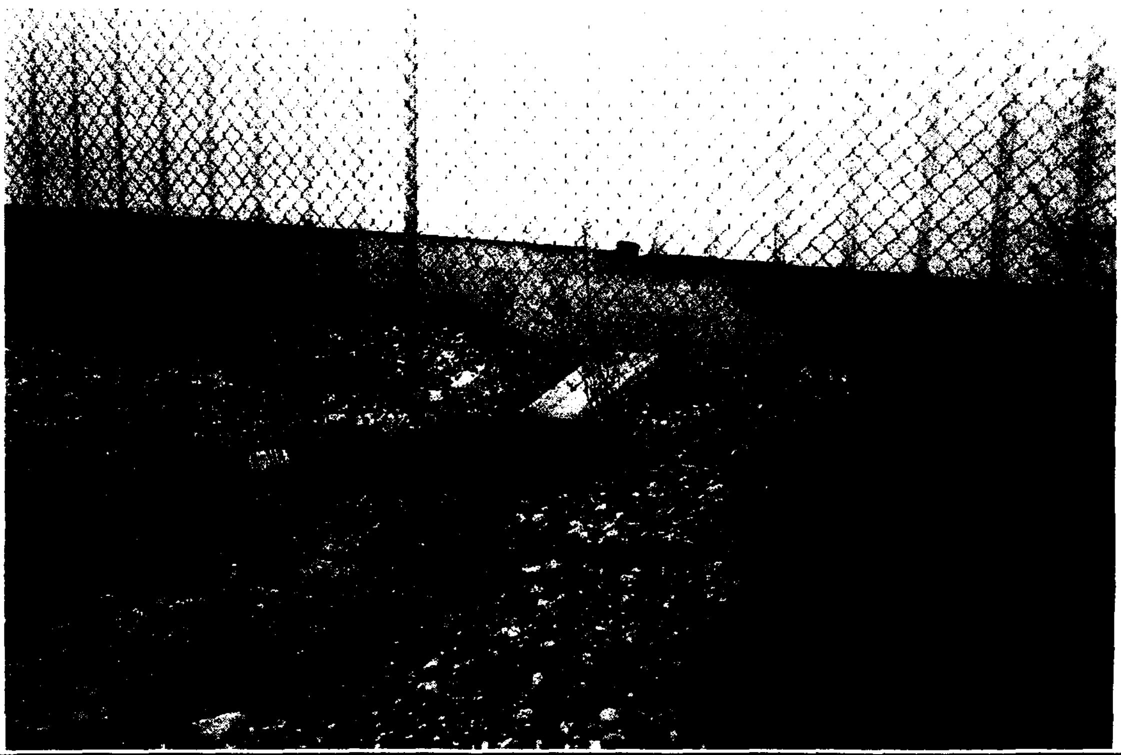
DESCRIPTION: View of drainage ditch adjacent to tracks off site.

PHOTO NUMBER: 4

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: Fast

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View of West side of Building No. 1 showing the drainage from the building flowing Westward and the gap underneath the fence.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: **Riverdale Chemical Company**

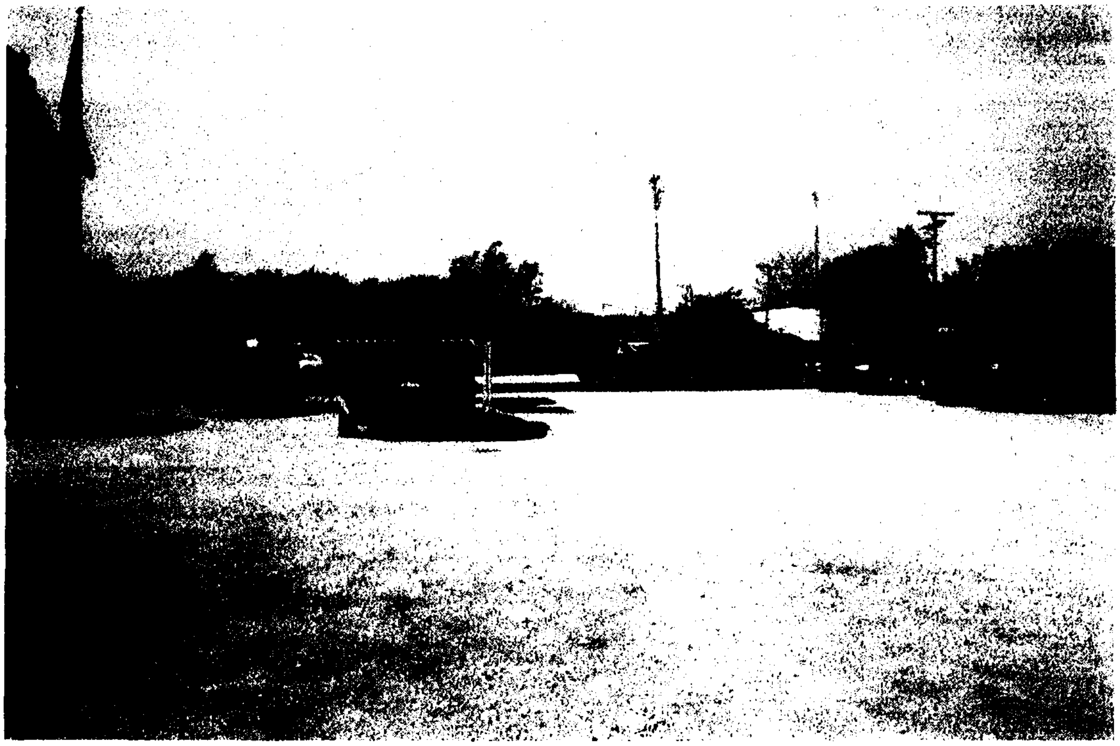
JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 5

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: West

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View West of the parking lot showing trees and vegetation off site.

PHOTO NUMBER: 6

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: Northwest

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: Standing water in wetland area located to the North.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: Riverdale Chemical Company

JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 7

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: Northwest

PHOTOGRAPHED BY: Anne Busher

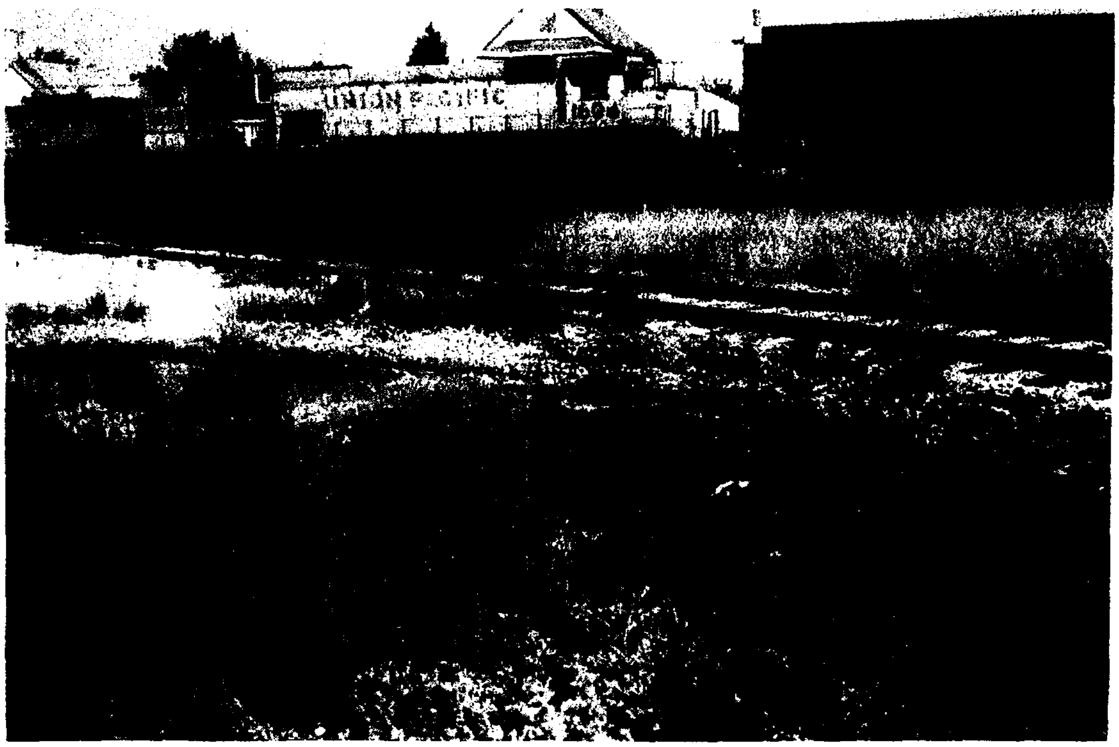
DESCRIPTION: View to North edge of site and adjacent rail. View water drainage patterns adjacent to building.

PHOTO NUMBER: 8

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: Northwest

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View of standing water and rail at Northern edge of the site.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: Riverdale Chemical Company

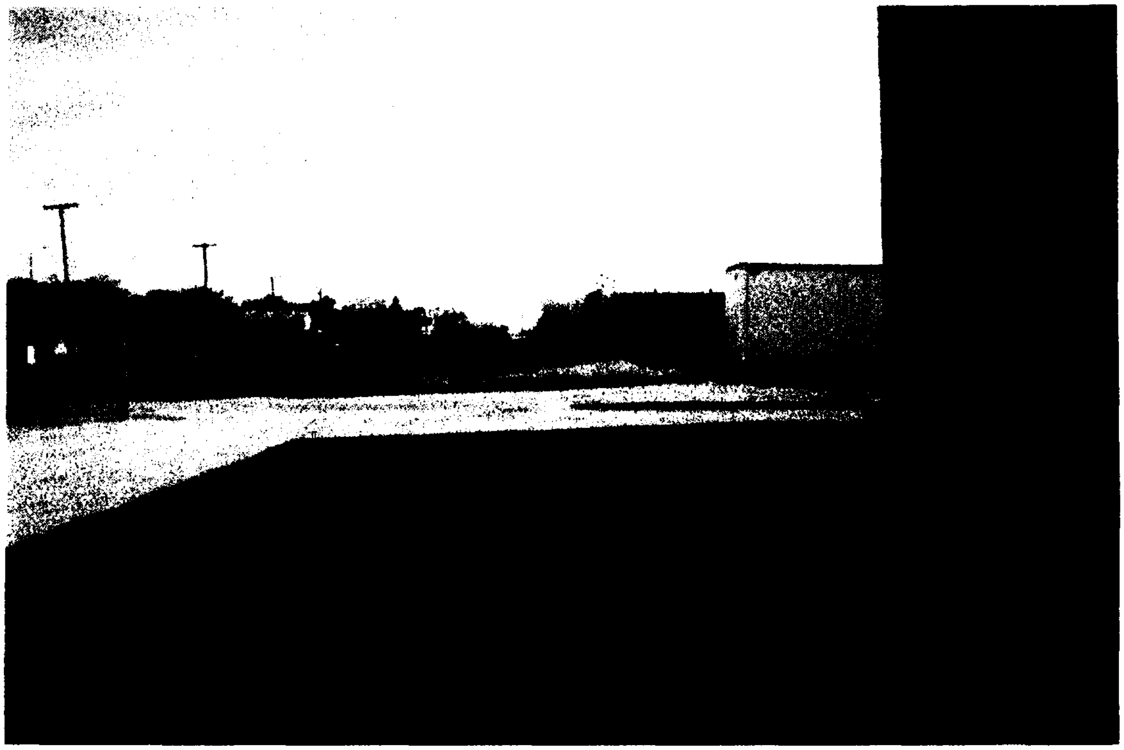
JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 9

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: East

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View to the East across the parking lot.

PHOTO NUMBER: 10

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: South

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View of racoon tracks adjacent to fence in fire corridor.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: Riverdale Chemical Company

JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 11

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: East

PHOTOGRAPHED BY: Anne Busher

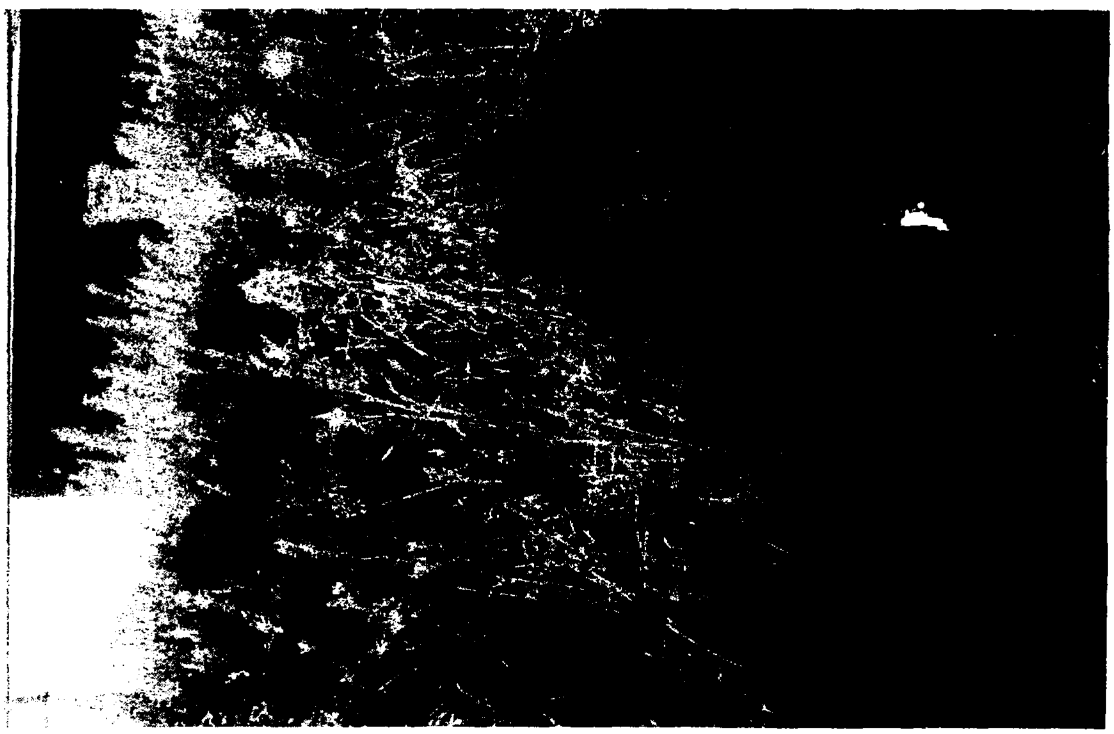
DESCRIPTION: View of filamentous algae in the drainage ditch.

PHOTO NUMBER: 12

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: South

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View of cattails adjacent to the drainage ditch.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET	
FACILITY NAME: **Riverdale Chemical Company**	
JOB NUMBER: 000607KJ0505 059G1101REXX	
PHOTO NUMBER: 13 **DATE:** 10/12/99 **DIRECTION OF PHOTOGRAPH:** East **PHOTOGRAPHED BY:** Anne Busher	
DESCRIPTION:	View of new limestone and drainage located at the Southern edge of the site.
PHOTO NUMBER: 14 **DATE:** 10/12/99 **DIRECTION OF PHOTOGRAPH:** Southeast **PHOTOGRAPHED BY:** Anne Busher	
DESCRIPTION:	View of wetland area in Southeast corner.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: Riverdale Chemical Company

JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 15

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: Northeast

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View East from the Southeast corner of the gravel area of the wetland area.

PHOTO NUMBER: 16

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: Northeast

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View of drainage towards Northeast of wetland area.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: Riverdale Chemical Company

JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER:
17

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH:
East

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: Chemical storage facility with view of sloped land causing drainage towards wetland area.

PHOTO NUMBER:
18

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH:
Northeast

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View of drainage from chemical storage area towards the wetland area.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET	
FACILITY NAME: Riverdale Chemical Company	**PAGE 10 OF 13**
JOB NUMBER: 000607KJ0505 059G1101REXX	
PHOTO NUMBER: 19 **DATE:** 10/12/99 **DIRECTION OF PHOTOGRAPH:** South **PHOTOGRAPHED BY:** Anne Busher	
DESCRIPTION:	View to the South along the edge of the chemical storage area.
PHOTO NUMBER: 20 **DATE:** 10/12/99 **DIRECTION OF PHOTOGRAPH:** South **PHOTOGRAPHED BY:** Anne Busher	
DESCRIPTION:	Closer view to the South along the edge of the chemical storage area.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER: 21

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: East

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View East to Northeast of large vegetation area.

PHOTO NUMBER: 22

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: North

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View of stressed vegetation where herbicide was sprayed to control sand burr growth.

ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET

FACILITY NAME: **Riverdale Chemical Company**

JOB NUMBER: 000607KJ0505 059G1101REXX

PHOTO NUMBER:
23

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH:
North

PHOTOGRAPHED BY: Anne Busher

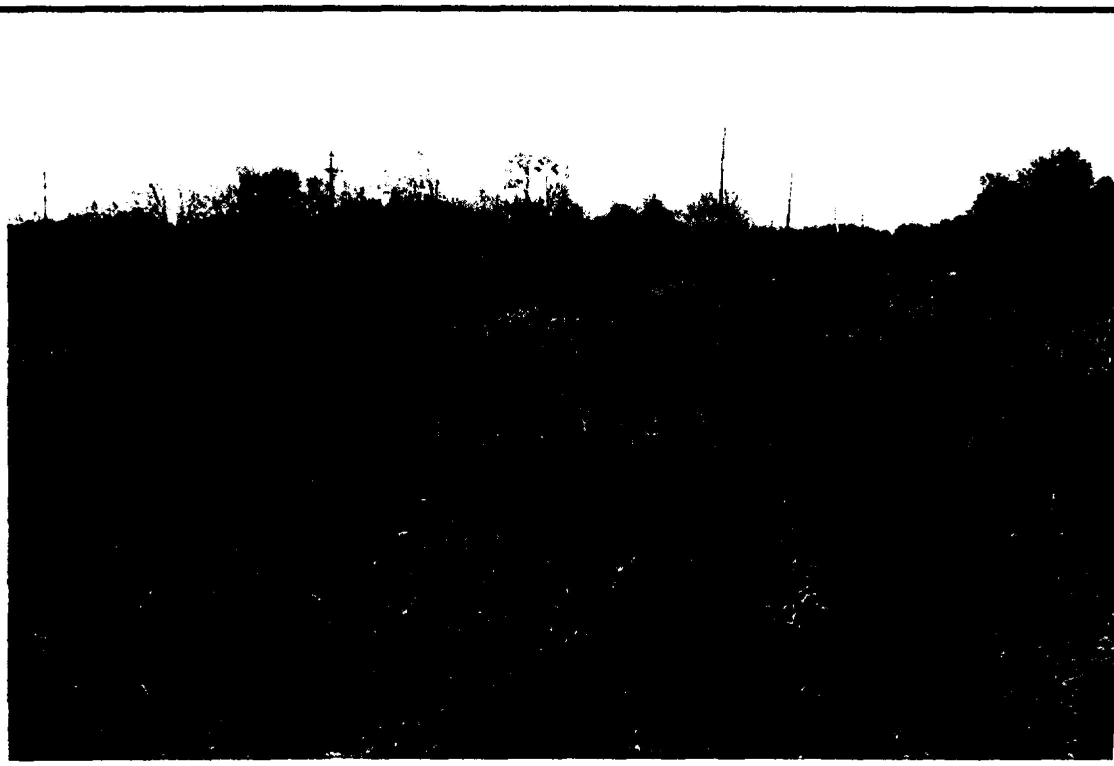
DESCRIPTION: Close up view of stressed vegetation.

PHOTO NUMBER:
24

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH:
Southeast

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: View back along Eastern edge of site.

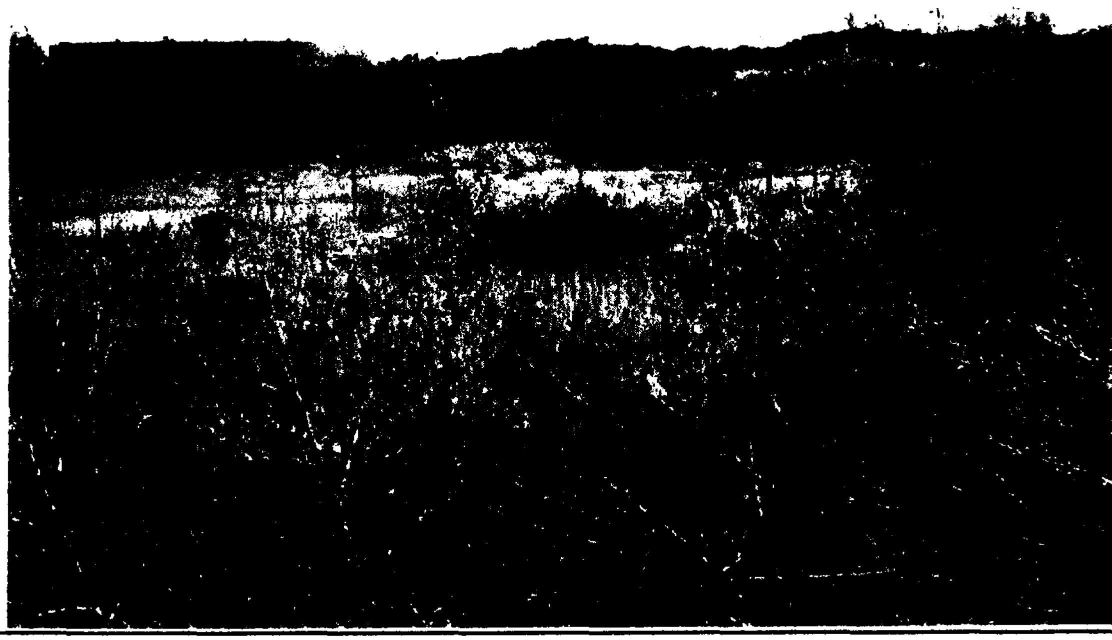
ECOLOGICAL SURVEY PHOTOGRAPHY LOG SHEET	
FACILITY NAME: **Riverdale Chemical Company**	**PAGE 13 OF 13**
JOB NUMBER: 000607KJ0505 059G1101REXX	

PHOTO NUMBER: 25

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: East

PHOTOGRAPHED BY: Anne Busher



DESCRIPTION: Northeast corner of site.

PHOTO NUMBER: 26

DATE: 10/12/99

DIRECTION OF PHOTOGRAPH: West

PHOTOGRAPHED BY: Anne Busher

DESCRIPTION: View from corner of Northeast building toward loading dock showing water drainage.

B

Threatened or Endangered Plants and Animals

(This appendix will be provided with the next submittal.)

C

Risk Assessment Standard Tables

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current and Future	Soil	Surface soil	Onsite	Industrial Worker	Adult	Ingestion	On-Site	Quant	Soil contaminants exceeded screening toxicity values.
						Dermal	On-Site	Quant	Soil contaminants exceeded screening toxicity values.
						Inhalation	On-Site	Qual	RI risk assessment for the site showed exposure via this pathway to be negligible.
		Surface and subsurface soil	Onsite	Construction/ Utility Worker	Adult	Ingestion	On-Site	Quant	Soil contaminants exceeded screening toxicity values.
						Dermal	On-Site	Quant	Soil contaminants exceeded screening toxicity values.
						Inhalation	On-Site	Qual	RI risk assessment for the site showed exposure via this pathway to be negligible.

Source: Ecology and Environment, Inc., 2000.

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current and Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Onsite

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	Volatiles															
79-34-5	1,1,2,2-Tetrachloroethane	5	J	5	J	ug/kg	B-6	2/14	5. - 5.	5	NA	29 C	NA	IPCB I/C Soil RO	NO	BSL
108-10-1	4-Methyl-2-pentanone	20	J	20	J	ug/kg	B-6	1/14	20. - 20.	20	NA	16,000 N	NA	IPCB I/C Soil RO	NO	BSL
67-64-1	Acetone	68		68		ug/kg	SS(01,02,17,18)	1/11	20. - 20.	68	NA	20,000 N	200,000	IPCB I/C Soil RO	NO	BSL
108-90-7	Chlorobenzene	2.1	J	3.5	J	ug/kg	SB(03,04)	2/11	5. - 55.	3.5	NA	4,100 N	41,000	IPCB I/C Soil RO	NO	BSL
67-66-3	Chloroform	5	J	14		ug/kg	B-6	2/14	5. - 5.	14	NA	940 C	940	IPCB I/C Soil RO	NO	BSL
100-41-4	Ethylbenzene	2.45	J	25		ug/kg	B-14	3/25	5. - 5.	25	NA	20,000 N	200,000	IPCB I/C Soil RO	NO	BSL
75-09-2	Methylene chloride	10		120		ug/kg	B-5	6/25	5. - 91.	120	NA	760 C	760	IPCB I/C Soil RO	NO	BSL
100-42-5	Styrene	5	J	5	J	ug/kg	B-2	1/14	5. - 5.	5	NA	41,000 N	410,000	IPCB I/C Soil RO	NO	BSL
127-18-4	Tetrachloroethene	2	J	5	J	ug/kg	B-1	6/25	5. - 5.	5	NA	110 C	110	IPCB I/C Soil RO	NO	BSL
108-88-3	Toluene	2	J	14		ug/kg	SB(03,04)	5/25	5. - 5.	14	NA	41,000 N	410,000	IPCB I/C Soil RO	NO	BSL
1330-20-7	Xylenes, total	5	J	94		ug/kg	B-14	3/25	5. - 11.	94	NA	410,000 N	1,000,000	IPCB I/C Soil RO	NO	BSL
	Semivolatiles															
120-82-1	1,2,4-Trichlorobenzene	870		870		ug/kg	B-10	1/15	330. - 330.	870	NA	2,000 N	20,000	IPCB I/C Soil RO	NO	BSL
95-95-4	2,4,5-Trichlorophenol	9,500		9,500		ug/kg	B-7	1/15	330. - 330.	9,500	NA	20,000 N	200,000	IPCB I/C Soil RO	NO	BSL
88-06-2	2,4,6-Trichlorophenol	330	J	4,500		ug/kg	B-7	5/15	330. - 330.	4,500	NA	520 C	520	IPCB I/C Soil RO	YES	ASL
120-83-2	2,4-Dichlorophenol	330	J	22,000		ug/kg	B-7	4/25	330. - 330.	22,000	NA	610 N	6,100	IPCB I/C Soil RO	YES	ASL
91-57-6	2-Methylnaphthalene	250	J	19,000		ug/kg	B-14	10/25	330. - 330.	19,000	NA	4,100 N	NA	IPCB I/C Soil RO	YES	ASL
95-48-7	2-Methylphenol	305	J	305	J	ug/kg	SS(04,05,06,07)	1/10	330. - 330.	305	NA	10,000 N	100,000	IPCB I/C Soil RO	NO	BSL
106-47-8	4-Chloroaniline	36,000		36,000		ug/kg	B-5	1/15	330. - 330.	36,000	NA	820 N	8,200	IPCB I/C Soil RO	YES	ASL
83-32-9	Acenaphthene	150	J	430		ug/kg	B-8	2/25	330. - 330.	430	NA	12,000 N	120,000	IPCB I/C Soil RO	NO	BSL
208-96-8	Acenaphthylene	95	J	470		ug/kg	B-9	6/25	330. - 330.	470	NA	NA	NA	IPCB I/C Soil RO	NO	NTX
120-12-7	Anthracene	150	J	1,100		ug/kg	SB(07,08)	5/10	330. - 330.	1,100	NA	61,000 N	610,000	IPCB I/C Soil RO	NO	BSL
56-55-3	Benzo[a]anthracene	330	J	5,800		ug/kg	SB(07,08)	14/25	330. - 6,800	5,800	NA	8 C	8	IPCB I/C Soil RO	YES	ASL
50-32-8	Benzo[a]pyrene	200		4,000		ug/kg	SB(07,08)	11/25	330. - 330.	4,000	NA	1 C	1	IPCB I/C Soil RO	YES	ASL
205-99-2	Benzo[b]fluoranthene	330	J	3,700		ug/kg	B-8	13/25	330. - 330.	3,700	NA	8 C	8	IPCB I/C Soil RO	YES	ASL
191-24-2	Benzo[g,h,i]perylene	240	J	1,900		ug/kg	SB(07,08)	9/25	330. - 330.	1,900	NA	NA	NA	IPCB I/C Soil RO	NO	NTX
207-08-9	Benzo[k]fluoranthene	330	J	3,700		ug/kg	B-8	12/25	330. - 330.	3,700	NA	78 C	78	IPCB I/C Soil RO	YES	ASL
117-81-7	Bis(2-ethylhexyl)phthalate	180	J	2,100	J	ug/kg	SS(01,02,17,18)	10/25	330. - 330.	2,100	NA	410 C	410	IPCB I/C Soil RO	YES	ASL
85-68-7	Butylbenzylphthalate	500		1,400		ug/kg	SB(01,02)	6/10	330. - 330.	1,400	NA	41,000 N	410,000	IPCB I/C Soil RO	NO	BSL
218-01-9	Chrysene	330	J	6,100		ug/kg	SB(07,08)	15/25	330. - 330.	6,100	NA	780 C	780	IPCB I/C Soil RO	YES	ASL
117-84-0	Di-n-octylphthalate	5,100		5,100		ug/kg	B-12	1/15	330. - 330.	5,100	NA	4,100 N	41,000	IPCB I/C Soil RO	YES	ASL
132-64-9	Dibenzofuran	120	J	120	J	ug/kg	SS(12,13,14)	1/1	330 - 330	120	NA	820 N	NA	IPCB I/C Soil RO	NO	NTX
206-44-0	Fluoranthene	120		7,200		ug/kg	SB(07,08)	18/25	330 - 330.	7,200	NA	8,200 N	82,000	IPCB I/C Soil RO	NO	BSL
86-73-7	Fluorene	183	J	2,000		ug/kg	SB(03,04,)	4/10	330. - 330.	2,000	NA	8,200 N	82,000	IPCB I/C Soil RO	NO	BSL
118-74-1	Hexachlorobenzene	330	J	330	J	ug/kg	B-9	1/15	330. - 330.	330	NA	4 C	4	IPCB I/C Soil RO	YES	ASL

Source: Ecology and Environment, Inc., 2000

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current and Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Onsite

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
	Semivolatiles															
193-39-5	Indeno[1,2,3-cd]pyrene	210	J	1,900		ug/kg	SB(07,08)	8/25	330. - 330.	1,900	NA	8 C	8	IPCB I/C Soil RO	YES	ASL
78-59-1	Isophorone	330	J	330	J	ug/kg	B-10	1/15	330. - 330.	330	NA	6,000 C	410,000	IPCB I/C Soil RO	NO	BSL
91-20-3	Naphthalene	160	J	6,400		ug/kg	B-14	10/25	330. - 330.	6,400	NA	4,100 N	82,000	IPCB I/C Soil RO	YES	ASL
85-01-8	Phenanthrene	330	J	4,900		ug/kg	SS(12,13,14)	13/25	330. - 330.	4,900	NA	NA	NA	IPCB I/C Soil RO	NO	NTX
108-95-2	Phenol	330	J	330	J	ug/kg	B-2	1/15	330. - 330.	330	NA	120,000 N	1,000,000	IPCB I/C Soil RO	NO	BSL
129-00-0	Pyrene	330	K	8,700		ug/kg	SB(07,08)	17/25	330. - 330.	8,700	NA	6,100 N	61,000	IPCB I/C Soil RO	YES	ASL
	Pesticides															
72-54-8	4,4'-DDD	20		37,000		ug/kg	SS(01,02,17,18)	16/40	5. - 5.	37,000	NA	24.00 C	24	IPCB I/C Soil RO	YES	ASL
72-55-9	4,4'-DDE	52		9,300		ug/kg	B-3	14/28	5. - 5.	9,300	NA	17.00 C	17	IPCB I/C Soil RO	YES	ASL
50-29-3	4,4'-DDT	93		33,000		ug/kg	SS(15,16)	27/40	5. - 5.	33,000	NA	17.00 C	17	IPCB I/C Soil RO	YES	ASL
309-00-2	Aldrin	18		530,000		ug/kg	SS(15,16)	35/40	3. - 3.	530,000	NA	0.34 C	0	IPCB I/C Soil RO	YES	ASL
319-84-6	alpha-BHC	14		2,600		ug/kg	SS(15,16)	4/14	3. - 3.	2,600	NA	0.91 C	1	IPCB I/C Soil RO	YES	ASL
319-85-7	beta-BHC	21		2,400		ug/kg	SS(01,02,17,18)	3/10	3. - 3.	2,400	NA	3.20 C	NA	IPCB I/C Soil RO	YES	ASL
57-74-9	Chlordane, technical	78		1,100,000		ug/kg	SS(15,16)	34/40	100. - 100.	1,100,000	NA	16.00 C	4	IPCB I/C Soil RO	YES	ASL
60-57-1	Dieldrin	45		210,000		ug/kg	SS(08,09,10,11)	38/40	3. - 3.	210,000	NA	0.36 C	0	IPCB I/C Soil RO	YES	ASL
72-20-8	Endrin	110		5,100		ug/kg	SS43	3/16	3. - 3.	5,100	NA	61.00 N	610	IPCB I/C Soil RO	YES	ASL
53494-70-5	Endrin ketone	77		13,000		ug/kg	SS11-2	16/26	5. - 5.	13,000	NA	NA	NA	IPCB I/C Soil RO	NO	NTX
58-89-9	gamma-BHC (Lindane)	11		130		ug/kg	SS43	5/26	3. - 3.	130	NA	4.40 C	4	IPCB I/C Soil RO	YES	ASL
76-44-8	Heptachlor	18		190,000		ug/kg	B-2	32/40	3. - 3.	190,000	NA	1.30 C	1	IPCB I/C Soil RO	YES	ASL
1024-57-3	Heptachlor epoxide	46		3,000		ug/kg	SS36	16/26	3. - 3.	3,000	NA	0.63 C	1	IPCB I/C Soil RO	YES	ASL
72-43-5	Methoxychlor	3,400		3,556		ug/kg	SS(04,05,06,07)	2/22	25. - 25.	3,556	NA	1,000.00 N	10,000	IPCB I/C Soil RO	NO	BSL
8001-35-2	Toxaphene	160,000		160,000		ug/kg	B-1	1/14	100. - 100.	160,000	NA	5.20 C	5	IPCB I/C Soil RO	YES	ASL
	Dioxins/Furans															
1746-01-6	2,3,7,8-TCDD	0.18		364		ug/kg	B-7	35/60	0.004 - 0.004	364	NA	0.000038 C	NA	IPCB I/C Soil RO	YES	ASL

(1) Minimum/maximum detected concentration.

(2) N/A - Refer to supporting information for background discussion.
Background values derived from statistical analysis. Follow Regional guidance and provide supporting information.

(3) Provide reference for screening toxicity value.

(4) Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Below Screening Level (BSL)

Definitions:
N/A = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

Source: Ecology and Environment, Inc., 2000

3/1/00

C-5

TABLE 3.1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface Soil
Exposure Point:	Onsite

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal / Lognormal Data (1)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
2,3,7,8-TCDD	mg/kg	1.5E-02	1.2E+02	3.6E-01	None	mg/kg	3.6E-01	Max Detected	(4)	NE	NA	NA
2,4,6-Trichlorophenol	mg/kg	7.0E-01	1.4E+00	4.5E+00	None	mg/kg	1.4E+00	95% UCL-L	W-test (3)	NE	NA	NA
2,4-Dichlorophenol	mg/kg	1.1E+00	6.1E-01	2.2E+01	None	mg/kg	6.1E-01	95% UCL-L	W-test (3)	NE	NA	NA
2-Methylnaphthalene	mg/kg	1.5E+00	2.0E+00	1.9E+01	None	mg/kg	2.0E+00	95% UCL-L	W-test (3)	NE	NA	NA
4,4'-DDD	mg/kg	4.2E+00	1.4E+03	3.7E+01	None	mg/kg	3.7E+01	Max Detected	(4)	NE	NA	NA
4,4'-DDE	mg/kg	1.1E+00	2.6E+02	9.3E+00	None	mg/kg	9.3E+00	Max Detected	(4)	NE	NA	NA
4,4'-DDT	mg/kg	4.3E+00	2.5E+03	3.3E+01	None	mg/kg	3.3E+01	Max Detected	(4)			
4-Chloroaniline	mg/kg	2.6E+00	2.2E+00	3.6E+01	None	mg/kg	2.2E+00	95% UCL-L	W-test (3)	NE	NA	NA
Aldrin	mg/kg	4.0E+01	8.7E+04	5.3E+02	None	mg/kg	5.3E+02	Max Detected	(4)	NE	NA	NA
alpha-BHC	mg/kg	1.9E-01	7.8E-01	2.6E+00	None	mg/kg	7.8E-01	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[a]anthracene	mg/kg	8.6E-01	1.5E+00	5.8E+00	None	mg/kg	1.5E+00	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[a]pyrene	mg/kg	5.9E-01	8.6E-01	4.0E+00	None	mg/kg	8.6E-01	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[b]fluoranthene	mg/kg	8.1E-01	1.5E+00	3.7E+00	None	mg/kg	1.5E+00	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[k]fluoranthene	mg/kg	7.7E-01	1.3E+00	3.7E+00	None	mg/kg	1.3E+00	95% UCL-L	W-test (3)	NE	NA	NA
beta-BHC	mg/kg	2.6E-01	6.2E+01	2.4E+00	None	mg/kg	2.4E+00	Max Detected	(4)	NE	NA	NA
Bis(2-ethylhexyl)phthalate	mg/kg	4.3E-01	5.9E-01	2.1E+00	None	mg/kg	5.9E-01	95% UCL-L	W-test (3)	NE	NA	NA
Chlordane, technical	mg/kg	7.0E+01	7.4E+03	1.1E+03	None	mg/kg	1.1E+03	Max Detected	(4)	NE	NA	NA
Chrysene	mg/kg	9.7E-01	1.7E+00	6.1E+00	None	mg/kg	1.7E+00	95% UCL-L	W-test (3)	NE	NA	NA
Di-n-octylphthalate	mg/kg	4.9E-01	1.1E+00	5.1E+00	None	mg/kg	1.1E+00	95% UCL-N	W-test (2)	NE	NA	NA
Dieldrin	mg/kg	3.2E+01	4.2E+03	2.1E+02	None	mg/kg	2.1E+02	Max Detected	(4)	NE	NA	NA
Endrin	mg/kg	3.8E-01	6.8E+00	5.1E+00	None	mg/kg	5.1E+00	Max Detected	(4)	NE	NA	NA
gamma-BHC (Lindane)	mg/kg	1.2E-02	2.0E-02	1.3E-01	None	mg/kg	2.0E-02	95% UCL-L	W-test (3)	NE	NA	NA
Heptachlor	mg/kg	1.5E+01	6.2E+04	1.9E+02	None	mg/kg	1.9E+02	Max Detected	(4)	NE	NA	NA
Heptachlor epoxide	mg/kg	5.0E-01	1.2E+02	3.0E+00	None	mg/kg	3.0E+00	Max Detected	(4)	NE	NA	NA
Hexachlorobenzene	mg/kg	1.8E-01	1.9E-01	3.3E-01	None	mg/kg	1.9E-01	95% UCL-L	W-test (3)	NE	NA	NA
Indeno[1,2,3-cd]pyrene	mg/kg	3.6E-01	4.6E-01	1.9E+00	None	mg/kg	4.6E-01	95% UCL-L	W-test (3)	NE	NA	NA
Naphthalene	mg/kg	5.6E-01	6.5E-01	6.4E+00	None	mg/kg	6.5E-01	95% UCL-L	W-test (3)	NE	NA	NA
Pyrene	mg/kg	1.4E+00	2.7E+00	8.7E+00	None	mg/kg	2.7E+00	95% UCL-L	W-test (3)	NE	NA	NA
Toxaphene	mg/kg	1.1E+01	3.2E+01	1.6E+02	None	mg/kg	3.2E+01	95% UCL-N	W-test (2)	NE	NA	NA

Footnotes on following page.

Source: Ecology and Environment, Inc., 2000.

TABLE 3.1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
RIVERDALE CHEMICAL COMPANY SITE

Footnotes

For non-detects, 1/2 the sample quantitation limit was used as a proxy concentration; for replicate sample results, the average value was used in the calculation.
W - Test: Developed by Shapiro and Wilk, refer to U.S. EPA 1992e, Supplemental guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.
Statistics: 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-normal Data (95% UCL-L); Maximum Detected Value (Max detected); Single Sample Data Set (Single Sample).
EPC: Exposure Point Concentration.
NA: Not Applicable.
NE: Not Evaluated.
B = Reported value is less than the CRDL but greater than the IDL.
J = Estimated value.
P = Greater than a 25% difference between the results on the primary and secondary columns. The lower value is reported.

(1) 95% UCLs were calculated using the formula appropriate for the distribution (normal or log-normal) that best fit the data.
(2) Shapiro-Wilk W - test indicates the data are more nearly normally distributed than log-normally distributed.
(3) Shapiro-Wilk W - test indicates the data are more nearly log-normally distributed than normally distributed.
(4) The 95% UCL, calculated using the formula appropriate for the distribution (normal or log-normal) that best fit the data, exceeded the maximum detected concentration.

TABLE 3.2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface and Subsurface Soil
Exposure Point:	Onsite

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal / Lognormal Data (1)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
2,3,7,8-TCDD	mg/kg	1.2E-02	2.3E-02	3.6E-01	None	mg/kg	2.3E-02	95% UCL-N	W-test (2)	NE	NA	NA
2,4,6-Trichlorophenol	mg/kg	7.0E-01	1.4E+00	4.5E+00	None	mg/kg	1.4E+00	95% UCL-L	W-test (3)	NE	NA	NA
2,4-Dichlorophenol	mg/kg	1.1E+00	6.1E-01	2.2E+01	None	mg/kg	6.1E-01	95% UCL-L	W-test (3)	NE	NA	NA
2-Methylnaphthalene	mg/kg	1.5E+00	2.0E+00	1.9E+01	None	mg/kg	2.0E+00	95% UCL-L	W-test (3)	NE	NA	NA
4,4'-DDD	mg/kg	4.2E+00	1.4E+03	3.7E+01	None	mg/kg	3.7E+01	Max Detected	(4)	NE	NA	NA
4,4'-DDE	mg/kg	1.1E+00	2.6E+02	9.3E+00	None	mg/kg	9.3E+00	Max Detected	(4)	NE	NA	NA
4,4'-DDT	mg/kg	4.3E+00	2.5E+03	3.3E+01	None	mg/kg	3.3E+01	Max Detected	(4)	NE	NA	NA
4-Chloroaniline	mg/kg	2.6E+00	2.2E+00	3.6E+01	None	mg/kg	2.2E+00	95% UCL-L	W-test (3)	NE	NA	NA
Aldrin	mg/kg	4.0E+01	8.7E+04	5.3E+02	None	mg/kg	5.3E+02	Max Detected	(4)	NE	NA	NA
alpha-BHC	mg/kg	1.9E-01	7.8E-01	2.6E+00	None	mg/kg	7.8E-01	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[a]anthracene	mg/kg	8.6E-01	1.5E+00	5.8E+00	None	mg/kg	1.5E+00	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[a]pyrene	mg/kg	5.9E-01	8.6E-01	4.0E+00	None	mg/kg	8.6E-01	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[b]fluoranthene	mg/kg	8.1E-01	1.5E+00	3.7E+00	None	mg/kg	1.5E+00	95% UCL-L	W-test (3)	NE	NA	NA
Benzo[k]fluoranthene	mg/kg	7.7E-01	1.3E+00	3.7E+00	None	mg/kg	1.3E+00	95% UCL-L	W-test (3)	NE	NA	NA
beta-BHC	mg/kg	2.6E-01	6.2E+01	2.4E+00	None	mg/kg	2.4E+00	Max Detected	(4)	NE	NA	NA
Bis(2-ethylhexyl)phthalate	mg/kg	4.3E-01	5.9E-01	2.1E+00	None	mg/kg	5.9E-01	95% UCL-L	W-test (3)	NE	NA	NA
Chlordane, technical	mg/kg	7.0E+01	7.4E+03	1.1E+03	None	mg/kg	1.1E+03	Max Detected	(4)	NE	NA	NA
Chrysene	mg/kg	9.7E-01	1.7E+00	6.1E+00	None	mg/kg	1.7E+00	95% UCL-L	W-test (3)	NE	NA	NA
Di-n-octylphthalate	mg/kg	4.9E-01	1.1E+00	5.1E+00	None	mg/kg	1.1E+00	95% UCL-N	W-test (2)	NE	NA	NA
Dieldrin	mg/kg	3.2E+01	4.2E+03	2.1E+02	None	mg/kg	2.1E+02	Max Detected	(4)	NE	NA	NA
Endrin	mg/kg	3.8E-01	6.8E+00	5.1E+00	None	mg/kg	5.1E+00	Max Detected	(4)	NE	NA	NA
gamma-BHC (Lindane)	mg/kg	1.2E-02	2.0E-02	1.3E-01	None	mg/kg	2.0E-02	95% UCL-L	W-test (3)	NE	NA	NA
Heptachlor	mg/kg	1.5E+01	6.2E+04	1.9E+02	None	mg/kg	1.9E+02	Max Detected	(4)	NE	NA	NA
Heptachlor epoxide	mg/kg	5.0E-01	1.2E+02	3.0E+00	None	mg/kg	3.0E+00	Max Detected	(4)	NE	NA	NA
Hexachlorobenzene	mg/kg	1.8E-01	1.9E-01	3.3E-01	None	mg/kg	1.9E-01	95% UCL-L	W-test (3)	NE	NA	NA
Indeno[1,2,3-cd]pyrene	mg/kg	3.6E-01	4.6E-01	1.9E+00	None	mg/kg	4.6E-01	95% UCL-L	W-test (3)	NE	NA	NA
Naphthalene	mg/kg	5.6E-01	6.5E-01	6.4E+00	None	mg/kg	6.5E-01	95% UCL-L	W-test (3)	NE	NA	NA
Pyrene	mg/kg	1.4E+00	2.7E+00	8.7E+00	None	mg/kg	2.7E+00	95% UCL-L	W-test (3)	NE	NA	NA
Toxaphene	mg/kg	1.1E+01	3.2E+01	1.6E+02	None	mg/kg	3.2E+01	95% UCL-N	W-test (2)	NE	NA	NA

Footnotes on following page.

Source: Ecology and Environment, Inc., 2000.

TABLE 3.2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
RIVERDALE CHEMICAL COMPANY SITE

Footnotes

For non-detects, 1/2 the sample quantitation limit was used as a proxy concentration; for replicate sample results, the average value was used in the calculation.
W - Test: Developed by Shapiro and Wilk, refer to U.S. EPA 1992e, Supplemental guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.
Statistics: 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-normal Data (95% UCL-L); Maximum Detected Value (Max detected); Single Sample Data Set (Single Value).
EPC: Exposure Point Concentration.
NA: Not Applicable.
NE: Not Evaluated.
J: Estimated value.

(1) 95% UCLs were calculated using the formula appropriate for the distribution (normal or log-normal) that best fit the data.
(2) Shapiro-Wilk W - test indicates the data are more nearly normally distributed than log-normally distributed.
(3) Shapiro-Wilk W - test indicates the data are more nearly log-normally distributed than normally distributed.
(4) The 95% UCL, calculated using the formula appropriate for the distribution (normal or log-normal) that best fit the data, exceeded the maximum detected concentration.
(5) The data set included only a single value usable for estimating the EPC.
(6) The total chromium concentrations reported were assumed to consist of 5/6ths chromium (III) and 1/6th chromium (VI).

Source: Ecology and Environment, Inc., 2000.

TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface Soil
Exposure Point:	Onsite
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	See Table 3.1	See Table 3.1	NE	NA	Chronic Daily Intake (CDI) (mg/kg-day) = CS x IR-S x FS x EF x ED x CF1 x 1/BW x 1/AT
	IR-S	Ingestion Rate of Soil	mg/day	50	U.S. EPA 1997a	NE	NA	
	FS	Fraction from Source	unitless	1	(1)	NE	NA	
	EF	Exposure Frequency	days/year	250	U.S. EPA 1991a	NE	NA	
	ED	Exposure Duration	years	21.9	U.S. EPA 1997b	NE	NA	
	CF1	Conversion Factor 1	kg/mg	0.000001	--	NE	NA	
	BW	Body Weight	kg	71.8	U.S. EPA 1997a	NE	NA	
	AT-C	Averaging Time (Cancer)	days	27,375	U.S. EPA 1997a	NE	NA	
	AT-N	Averaging Time (Non-Cancer)	days	7,994	U.S. EPA 1991a	NE	NA	
Dermal	CS	Chemical Concentration in Soil	mg/kg	See Table 3.1	See Table 3.1	NE	NA	Chronic Daily Intake (CDI) (mg/kg-day) = CS x SSAF x SA x DABS x EF x ED x CF1 x 1/BW x 1/AT
	SSAF	Soil to Skin Adherence Factor	mg/cm2-event	0.122	U.S. EPA 1997a	NE	NA	
	SA	Skin Surface Area Available for Contact	cm2	10,000	U.S. EPA 1997a	NE	NA	
	DABS	Dermal Absorption Factor (Solid)	unitless	See Table 4.3	See Table 4.3	NE	NA	
	EF	Exposure Frequency	days/year	250	U.S. EPA 1991a	NE	NA	
	ED	Exposure Duration	years	21.9	U.S. EPA 1997b	NE	NA	
	CF1	Conversion Factor 1	kg/mg	0.000001	--	NE	NA	
	BW	Body Weight	kg	71.8	U.S. EPA 1997a	NE	NA	
	AT-C	Averaging Time (Cancer)	days	27,375	U.S. EPA 1997a	NE	NA	
	AT-N	Averaging Time (Non-Cancer)	days	7,994	U.S. EPA 1991a	NE	NA	

References

U.S. EPA 1991a: Risk Assessment for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

U.S. EPA 1997a: Exposure Factors Handbook, Volume 1 - General Factors, Office of Research and Development, National Center for Environmental Assessment.

U.S. EPA 1997b: Exposure Factors Handbook, Volume 3 - Activity Factors, Office of Research and Development, National Center for Environmental Assessment.

(1) Professional Judgement.

NA: Not applicable.

NE: Not evaluated.

Source: Ecology and Environment, Inc., 2000.

TABLE 4.2
VALUES USED FOR DAILY INTAKE CALCULATIONS
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Surface and subsurface soil
Exposure Point:	Onsite
Receptor Population:	Construction/Utility Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	See Table 3.2	See Table 3.2	NE	NA	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-S	Ingestion Rate of Soil	mg/day	100	U.S. EPA 1997a	NE	NA	CS x IR-S x FS x EF x ED x CF1 x 1/BW x 1/AT
	FS	Fraction from Source	unitless	1	(1)	NE	NA	
	EF	Exposure Frequency	days/year	250	U.S. EPA 1991a	NE	NA	
	ED	Exposure Duration	years	1	U.S. EPA 1997b	NE	NA	
	CF1	Conversion Factor 1	kg/mg	0.000001	--	NE	NA	
	BW	Body Weight	kg	71.8	U.S. EPA 1997a	NE	NA	
	AT-C	Averaging Time (Cancer)	days	27,375	U.S. EPA 1997a	NE	NA	
	AT-N	Averaging Time (Non-Cancer)	days	365	U.S. EPA 1991a	NE	NA	
Dermal	CS	Chemical Concentration in Soil	mg/kg	See Table 3.2	See Table 3.2	NE	NA	Chronic Daily Intake (CDI) (mg/kg-day) =
	SSAF	Soil to Skin Adherence Factor	mg/cm2-event	0.122	U.S. EPA 1997a	NE	NA	CS x SSAF x SA x DABS x EF x ED x CF1 x
	SA	Skin Surface Area Available for Contact	cm2	10,000	U.S. EPA 1997a	NE	NA	1/BW x 1/AT
	DABS	Dermal Absorption Factor (Solid)	unitless	See Table 4.3	See Table 4.3	NE	NA	
	EF	Exposure Frequency	days/year	250	U.S. EPA 1991a	NE	NA	
	ED	Exposure Duration	years	1	U.S. EPA 1997b	NE	NA	
	CF1	Conversion Factor 1	kg/mg	0.000001	--	NE	NA	
	BW	Body Weight	kg	71.8	U.S. EPA 1997a	NE	NA	
	AT-C	Averaging Time (Cancer)	days	27,375	U.S. EPA 1997a	NE	NA	
	AT-N	Averaging Time (Non-Cancer)	days	365	U.S. EPA 1991a	NE	NA	

References

U.S. EPA 1991a: Risk Assessment for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

U.S. EPA 1997a: Exposure Factors Handbook, Volume 1 - General Factors, Office of Research and Development, National Center for Environmental Assessment.

U.S. EPA 1997b: Exposure Factors Handbook, Volume 3 - Activity Factors, Office of Research and Development, National Center for Environmental Assessment.

(1) Professional Judgement.

NA: Not applicable.

NE: Not evaluated.

Source: Ecology and Environment, Inc., 2000.

TABLE 4.3
DERMAL AND GASTROINTESTINAL ABSORPTION FACTORS
RIVERDALE CHEMICAL COMPANY SITE

Chemical	Dermal Absorption Factor from Soil	Dermal Absorption Factor Source	Gastrointestinal Absorption Factor (1)	Gastrointestinal Absorption Factor Source
Aldrin	0.078	ATSDR 1992	0.750	ATSDR 1992; DDT & TCDD surrogates
Benzo[a]anthracene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
Benzo[a]pyrene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
Benzo[b]fluoranthene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
Benzo[k]fluoranthene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
Chlordane	0.040	ATSDR 1993	0.800	ATSDR 1993
Chloroaniline, p-	0.100	US EPA Reg IX RBC Table	1.000	Assumed
Chrysene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
Di(2-ethylhexyl)phthalate	0.200	ATSDR 1993	0.250	ATSDR 1993
Di-n-octyl phthalate	0.200	Surrogate: DEHP - ATSDR 1993	0.250	Surrogate: DEHP - ATSDR 1993
Dichlorodiphenyldichloroethane, p,p'-	0.013	US EPA Dermal Exposure Assessment Manual	0.750	ATSDR 1989; TCDD surrogate
Dichlorodiphenyldichloroethylene, p,p'-	0.013	US EPA Dermal Exposure Assessment Manual	0.750	ATSDR 1989; TCDD surrogate
Dichlorodiphenyltrichloroethane, p,p'-	0.013	US EPA Dermal Exposure Assessment Manual	0.750	ATSDR 1989; TCDD surrogate
Dichlorophenol, 2,4-	0.250	Surrogate: PCP	1.000	Surrogate PCP
Dieldrin	0.077	ATSDR 1992	0.900	ATSDR 1992; PCB surrogates
Endrin	0.100	US EPA Reg IX RBC Table	1.000	Assumed
Heptachlor	0.128	US EPA Reg IX PRG Table	0.780	ATSDR 1993
Heptachlor epoxide	0.100	US EPA Reg IX PRG Table	1.000	Assumed
Hexachlorobenzene	0.075	ATSDR 1996	0.800	ATSDR 1996
Hexachlorocyclohexane, alpha-	0.103	US EPA Reg IX PRG Table	0.970	ATSDR 1993
Hexachlorocyclohexane, beta-	0.110	US EPA Reg IX PRG Table	0.910	ATSDR 1993
Hexachlorocyclohexane, gamma-	0.040	Duff & Kissel 1996	0.990	ATSDR 1993
Indeno[1,2,3-cd]pyrene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
Methylnaphthalene, 2-	0.500	Surrogate: Naphthalene	1.000	Assumed
Naphthalene	0.500	ATSDR 1995	1.000	Assumed
Pyrene	0.130	US EPA Reg IX PRG Table	1.000	Assumed; point of contact
TCDD, 2,3,7,8-	0.030	US EPA 1994 Estimating Exposure to Dioxin-like Compounds, Vol. III	0.750	US EPA 1994 Estimating Exposure to Dioxin-like Compounds, Vol. I
Toxaphene	0.100	US EPA Reg IX RBC Table	1.000	Assumed
Trichlorophenol, 2,4,6-	0.250	Surrogate: PCP	1.000	Surrogate: PCP

Footnotes on next page.

Source: Ecology and Environment, Inc., 2000.

TABLE 4.3
DERMAL AND GASTROINTESTINAL ABSORPTION FACTORS
RIVERDALE CHEMICAL COMPANY SITE

Footnotes:

ATSDR year = Agency for Toxic Substances and Disease Registry Toxicological Profile for chemical.
IRIS = Integrated Risk Information System.
HEAST = Health Effects Assessment Summary Tables.
PRG = Preliminary remediation goal.
TCDD, 2,3,7,8- = 2,3,7,8-Tetrachlorodibenzo-p-dioxin.

(1) Used as oral to dermal adjustment factors for reference doses and cancer slope factors - see Tables 5.1 and 6.1.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
RIVERDALE CHEMICAL COMPANY SITE

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Aldrin	Chronic	3.0E-05	mg/kg-day	0.75	2.3E-05	mg/kg-day	Liver	1,000	IRIS	3/1/88
Aldrin	Subchronic	3.0E-05	mg/kg-day	0.75	2.3E-05	mg/kg-day	Liver	1,000	HEAST	7/1/97
Chlordane	Chronic	5.0E-04	mg/kg-day	0.80	4.0E-04	mg/kg-day	Liver	300	IRIS	2/7/98
Chlordane	Subchronic	5.0E-04	mg/kg-day	0.80	4.0E-04	mg/kg-day	Liver	300	CHRONIC ORAL	2/7/98
Chloroaniline, p-	Chronic	4.0E-03	mg/kg-day	1.00	4.0E-03	mg/kg-day	Spleen	3,000	IRIS	2/1/95
Chloroaniline, p-	Subchronic	4.0E-03	mg/kg-day	1.00	4.0E-03	mg/kg-day	Spleen	3,000	HEAST	5/31/95
Di(2-ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	0.25	5.0E-03	mg/kg-day	Liver	1,000	IRIS	5/1/91
Di-n-octyl phthalate	Chronic	2.0E-02	mg/kg-day	0.25	5.0E-03	mg/kg-day	Kidney	1,000	HEAST	5/31/95
Di-n-octyl phthalate	Subchronic	2.0E-02	mg/kg-day	0.25	5.0E-03	mg/kg-day	Kidney	1,000	HEAST	3/31/93
Dichlorodiphenyltrichloroethane, p,p'-	Chronic	5.0E-04	mg/kg-day	0.75	3.8E-04	mg/kg-day	Liver	100	IRIS	2/1/96
Dichlorodiphenyltrichloroethane, p,p'-	Subchronic	5.0E-04	mg/kg-day	0.75	3.8E-04	mg/kg-day	Liver	100	CHRONIC ORAL	3/31/93
Dichlorophenol, 2,4-	Chronic	3.0E-03	mg/kg-day	1.00	3.0E-03	mg/kg-day	Nervous system	100	IRIS	6/30/88
Dichlorophenol, 2,4-	Subchronic	3.0E-03	mg/kg-day	1.00	3.0E-03	mg/kg-day	Immune system	100	HEAST	3/31/93
Dieldrin	Chronic	5.0E-05	mg/kg-day	0.90	4.5E-05	mg/kg-day	Liver	100	IRIS	9/1/90
Dieldrin	Subchronic	5.0E-05	mg/kg-day	0.90	4.5E-05	mg/kg-day	Liver	100	HEAST	3/31/93
Endrin	Chronic	3.0E-04	mg/kg-day	1.00	3.0E-04	mg/kg-day	Liver	100	IRIS	4/1/91
Endrin	Subchronic	3.0E-04	mg/kg-day	1.00	3.0E-04	mg/kg-day	Central nervous system	100	HEAST	3/31/93
Heptachlor	Chronic	5.0E-04	mg/kg-day	0.78	3.9E-04	mg/kg-day	Liver	300	IRIS	3/1/91
Heptachlor	Subchronic	5.0E-04	mg/kg-day	0.78	3.9E-04	mg/kg-day	Liver	300	HEAST	3/31/93
Heptachlor epoxide	Chronic	1.3E-05	mg/kg-day	1.00	1.3E-05	mg/kg-day	Liver	1,000	IRIS	3/1/91
Heptachlor epoxide	Subchronic	1.3E-05	mg/kg-day	1.00	1.3E-05	mg/kg-day	Liver	1,000	HEAST	7/1/97
Hexachlorobenzene	Chronic	8.0E-04	mg/kg-day	0.80	6.4E-04	mg/kg-day	Liver	100	IRIS	4/1/91
Hexachlorocyclohexane, gamma-	Chronic	3.0E-04	mg/kg-day	0.99	3.0E-04	mg/kg-day	Liver	1,000	IRIS	3/1/88
Hexachlorocyclohexane, gamma-	Subchronic	3.0E-03	mg/kg-day	0.99	3.0E-03	mg/kg-day	Liver	100	HEAST	3/31/93
Naphthalene	Chronic	2.0E-02	mg/kg-day	1.00	2.0E-02	mg/kg-day	Whole body	3,000	IRIS	9/17/98
Pyrene	Chronic	3.0E-02	mg/kg-day	1.00	3.0E-02	mg/kg-day	Kidney	3,000	IRIS	7/1/93
Pyrene	Subchronic	3.0E-01	mg/kg-day	1.00	3.0E-01	mg/kg-day	Kidney	300	HEAST	7/31/97

(1) Refer to U.S. EPA 1989 RAGS, Part A. See Table 4.12 of this document for factor sources.

(2) Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor

(3) For IRIS values: date RfD was last revised;
For HEAST values: date of most recent HEAST update.

IRIS = Integrated Risk Information System.

HEAST = Health Effects Assessment Summary Tables.

CHRONIC ORAL = Extrapolated from Chronic Oral RfD

Source: Ecology and Environment, Inc., 2000

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
RIVERDALE CHEMICAL COMPANY SITE

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source Target Organ	Date (2) (MM/DD/YY)
Aldrin	1.7E+01	0.75	2.3E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	7/1/93
Benz[a]anthracene	7.3E-01	1.00	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	3/1/94
Benzo[a]pyrene	7.3E+00	1.00	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	11/1/94
Benzo[b]fluoranthene	7.3E-01	1.00	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	3/1/94
Benzo[k]fluoranthene	7.3E-02	1.00	7.3E-02	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	3/1/94
Chlordane	3.5E-01	0.80	4.4E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/7/98
Chloroaniline, p-	6.4E-02	1.00	6.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	OPP	12/15/87
Chrysene	7.3E-03	1.00	7.3E-03	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	3/1/94
Di(2-ethylhexyl)phthalate	1.4E-02	0.25	5.6E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/1/93
Dichlorodiphenyl dichloroethane, p,p'-	2.4E-01	0.75	3.2E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/22/88
Dichlorodiphenyldichloroethylene, p,p'-	3.4E-01	0.75	4.5E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/22/88
Dichlorodiphenyltrichloroethane, p,p'-	3.4E-01	0.75	4.5E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	5/1/91
Dieldrin	1.6E+01	0.90	1.8E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	7/1/93
Heptachlor	4.5E+00	0.78	5.8E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	7/1/93
Heptachlor epoxide	9.1E+00	1.00	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	7/1/93
Hexachlorobenzene	1.6E+00	0.80	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	11/1/96
Hexachlorocyclohexane, alpha-	6.3E+00	0.97	6.5E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	7/1/93
Hexachlorocyclohexane, beta-	1.8E+00	0.91	2.0E+00	$(mg/kg\text{-}day)^{-1}$	C	IRIS	7/1/93
Hexachlorocyclohexane, gamma-	1.8E+00	0.99	1.8E+00	$(mg/kg\text{-}day)^{-1}$	B2-C	IRIS	5/31/95
Indeno[1,2,3-cd]pyrene	7.3E-01	1.00	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	NC	3/1/94
TCDD 2,3,7,8	1.5E+05	0.75	2.0E+05	$(mg/kg\text{-}day)^{-1}$	B2	HE	5/31/95
Toxaphene	1.1E+00	1.00	1.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/1/91
Trichlorophenol, 2,4,6-	1.1E-02	1.00	1.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	2/1/94

Footnotes on following page.

Source: Ecology and Environment, Inc., 2000

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
RIVERDALE CHEMICAL COMPANY SITE

Footnotes

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
OPP = Office of Pesticide Programs

(1) See Table 4.12 for factor sources.
(2) Dermal Cancer Slope Factor = Oral Cancer Slope Factor / Oral to Dermal Adjustment Factor
(3) For IRIS entries, date carcinogenicity assessment was last revised.
For HEAST entries, date of most recent HEAST update.
For NCEA entries, date of NCEA article.
For OPP values, date of Health Effects Determination.

EPA Group:
- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

Weight of Evidence:
- Known/Likely
- Cannot be Determined
- Not Likely

Source: Ecology and Environment, Inc., 2000

TABLE 7.1.RME
CALCULATION OF NONCANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface Soil
Exposure Point:	Onsite
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Noncancer)	Intake (Noncancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Oral	2,3,7,8-TCDD	3.64E-01	mg/kg	3.64E-01	mg/kg	M	1.7E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	6.5E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	2.9E-07	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	9.6E-05
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	1.8E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	4.4E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	1.6E-05	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	3.1E-02
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	1.1E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	2.6E-04
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	2.5E-04	mg/kg-day	3.0E-05	mg/kg-day	NA	NA	8.4E+00
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	3.7E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	6.9E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	4.1E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	7.1E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	6.4E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	1.1E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	2.8E-07	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.4E-05
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	5.2E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.0E+00
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	8.0E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	5.1E-07	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.6E-05
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	1.0E-04	mg/kg-day	5.0E-05	mg/kg-day	NA	NA	2.0E+00
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	2.4E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	8.1E-03
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	9.4E-09	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	3.1E-05
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	9.1E-05	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.8E-01
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	1.4E-06	mg/kg-day	1.3E-05	mg/kg-day	NA	NA	1.1E-01
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	9.1E-08	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	1.1E-04
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	2.2E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Naphthalene	6.52E-01	mg/kg	6.52E-01	mg/kg	M	3.1E-07	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.6E-05
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	1.3E-06	mg/kg-day	3.0E-02	mg/kg-day	NA	NA	4.3E-05
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	1.5E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	(Total)												1.2E+01

Source: Ecology and Environment, Inc., 2000.

TABLE 7.1.RME
CALCULATION OF NONCANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface Soil
Exposure Point:	Onsite
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Noncancer)	Intake (Noncancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	2,3,7,8-TCDD	3.64E-01	mg/kg	3.64E-01	mg/kg	M	1.3E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	4.0E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	1.8E-06	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	5.9E-04
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	5.7E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	1.4E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	5.1E-06	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.4E-02
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	2.6E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	6.4E-04
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	4.8E-04	mg/kg-day	3.0E-05	mg/kg-day	NA	NA	2.1E+01
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	9.3E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	2.2E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	1.3E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	2.2E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	2.0E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	3.1E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	1.4E-06	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.8E-04
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	5.1E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.3E+00
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	2.6E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	2.5E-06	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	5.0E-04
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	1.9E-04	mg/kg-day	5.0E-05	mg/kg-day	NA	NA	4.2E+00
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	5.9E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.0E-02
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	9.2E-09	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	3.1E-05
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	2.8E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	7.3E-01
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	3.5E-06	mg/kg-day	1.3E-05	mg/kg-day	NA	NA	2.7E-01
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	1.7E-07	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	2.6E-04
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	6.9E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Naphthalene	6.52E-01	mg/kg	6.52E-01	mg/kg	M	3.8E-06	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.9E-04
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	4.1E-06	mg/kg-day	3.0E-02	mg/kg-day	NA	NA	1.4E-04
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	3.7E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	(Total)												2.8E+01
										Total Hazard Index Across All Exposure Routes/Pathways			4.0E+01

EPC: Exposure point concentration.
NA: Not available or not applicable.
NE: Not Evaluated
(1) Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.

Source: Ecology and Environment, Inc., 2000

TABLE 7.2.RME
CALCULATION OF NONCANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface and Subsurface Soil
Exposure Point:	Onsite
Receptor Population:	Construction Workers
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Noncancer)	Intake (Noncancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	2,3,7,8-TCDD	2.33E-02	mg/kg	2.33E-02	mg/kg	M	8.1E-09	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	4.0E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	1.8E-06	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	5.9E-04
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	5.7E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	1.4E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	5.1E-06	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.4E-02
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	2.6E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	6.4E-04
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	4.8E-04	mg/kg-day	3.0E-05	mg/kg-day	NA	NA	2.1E+01
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	9.3E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	2.2E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	1.3E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	2.2E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	2.0E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	3.1E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	1.4E-06	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.8E-04
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	5.1E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.3E+00
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	2.6E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	2.5E-06	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	5.0E-04
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	1.9E-04	mg/kg-day	5.0E-05	mg/kg-day	NA	NA	4.2E+00
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	5.9E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.0E-02
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	9.2E-09	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	3.1E-06
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	2.8E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	7.3E-01
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	3.5E-06	mg/kg-day	1.3E-05	mg/kg-day	NA	NA	2.7E-01
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	1.7E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	6.9E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	4.1E-06	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	1.4E-05
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	3.7E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	(Total)												2.8E+01
									Total Hazard Index Across All Exposure Routes/Pathways				5.1E+01

EPC: Exposure point concentration.
NA: Not available or not applicable.
NE: Not Evaluated
(1) Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.

Source: Ecology and Environment, Inc., 2000.

TABLE 7.2.RME
CALCULATION OF NONCANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface and Subsurface Soil
Exposure Point:	Onsite
Receptor Population:	Construction Workers
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Noncancer)	Intake (Noncancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Oral	2,3,7,8-TCDD	2.33E-02	mg/kg	2.33E-02	mg/kg	M	2.2E-08	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	1.3E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	5.8E-07	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	1.9E-04
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	3.5E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	8.9E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	3.1E-05	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	6.3E-02
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	2.1E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	5.3E-04
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	5.1E-04	mg/kg-day	3.0E-05	mg/kg-day	NA	NA	1.7E+01
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	7.4E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	1.4E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	8.2E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	1.4E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	1.3E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	2.3E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	5.6E-07	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.8E-05
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	1.0E-03	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	2.1E+00
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	1.6E-06	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	1.0E-06	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	5.1E-05
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	2.0E-04	mg/kg-day	5.0E-05	mg/kg-day	NA	NA	4.0E+00
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	4.9E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.6E-02
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	1.9E-08	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	6.3E-06
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	1.8E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	3.6E-01
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	2.9E-06	mg/kg-day	1.3E-05	mg/kg-day	NA	NA	2.2E-01
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	1.8E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	4.4E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	2.6E-06	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	8.5E-06
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	3.0E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	(Total)												2.4E+01

Source: Ecology and Environment, Inc., 2000.

TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface Soil
Exposure Point:	Onsite
Receptor Population:	Industrial Workers
Receptor Age:	Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Oral	2,3,7,8-TCDD	3.64E-01	mg/kg	3.64E-01	mg/kg	M	5.07E-08	mg/kg-day	1.50E+05	(mg/kg-day) -1	7.6E-03
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	1.89E-07	mg/kg-day	1.10E-02	(mg/kg-day) -1	2.1E-09
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	5.15E-06	mg/kg-day	2.40E-01	(mg/kg-day) -1	1.2E-06
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	1.30E-06	mg/kg-day	3.40E-01	(mg/kg-day) -1	4.4E-07
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	4.60E-06	mg/kg-day	3.40E-01	(mg/kg-day) -1	1.6E-06
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	3.08E-07	mg/kg-day	6.38E-02	(mg/kg-day) -1	2.0E-08
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	7.38E-05	mg/kg-day	1.70E+01	(mg/kg-day) -1	1.3E-03
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	1.08E-07	mg/kg-day	6.30E+00	(mg/kg-day) -1	6.8E-07
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	2.03E-07	mg/kg-day	7.30E-01	(mg/kg-day) -1	1.5E-07
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	1.19E-07	mg/kg-day	7.30E+00	(mg/kg-day) -1	8.7E-07
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	2.06E-07	mg/kg-day	7.30E-01	(mg/kg-day) -1	1.5E-07
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	1.86E-07	mg/kg-day	7.30E-02	(mg/kg-day) -1	1.4E-08
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	3.34E-07	mg/kg-day	1.80E+00	(mg/kg-day) -1	6.0E-07
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	8.23E-08	mg/kg-day	1.40E-02	(mg/kg-day) -1	1.2E-09
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	1.53E-04	mg/kg-day	3.50E-01	(mg/kg-day) -1	5.4E-05
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	2.35E-07	mg/kg-day	7.30E-03	(mg/kg-day) -1	1.7E-09
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	2.92E-05	mg/kg-day	1.60E+01	(mg/kg-day) -1	4.7E-04
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	2.75E-09	mg/kg-day	1.80E+00	(mg/kg-day) -1	4.9E-09
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	2.65E-05	mg/kg-day	4.50E+00	(mg/kg-day) -1	1.2E-04
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	4.18E-07	mg/kg-day	9.10E+00	(mg/kg-day) -1	3.8E-06
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	2.67E-08	mg/kg-day	1.60E+00	(mg/kg-day) -1	4.3E-08
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	6.35E-08	mg/kg-day	7.30E-01	(mg/kg-day) -1	4.6E-08
	Naphthalene	6.52E-01	mg/kg	6.52E-01	mg/kg	M	9.08E-08	mg/kg-day	NA	(mg/kg-day) -1	NA
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	4.42E-06	mg/kg-day	1.10E+00	(mg/kg-day) -1	4.9E-06
	(Total)										9.5E-03

Source: Ecology and Environment, Inc., 2000

TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface Soil
Exposure Point:	Onsite
Receptor Population:	Industrial Workers
Receptor Age:	Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	2,3,7,8-TCDD	3.64E-01	mg/kg	3.64E-01	mg/kg	M	3.71E-08	mg/kg-day	1.50E+05	(mg/kg-day) -1	7.4E-03
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	1.16E-06	mg/kg-day	1.10E-02	(mg/kg-day) -1	1.3E-08
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	1.68E-06	mg/kg-day	2.40E-01	(mg/kg-day) -1	5.4E-07
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	4.21E-07	mg/kg-day	3.40E-01	(mg/kg-day) -1	1.9E-07
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	1.50E-06	mg/kg-day	3.40E-01	(mg/kg-day) -1	6.8E-07
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	7.51E-07	mg/kg-day	6.38E-02	(mg/kg-day) -1	4.8E-08
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	1.40E-04	mg/kg-day	1.70E+01	(mg/kg-day) -1	3.2E-03
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	2.72E-07	mg/kg-day	6.30E+00	(mg/kg-day) -1	1.8E-06
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	6.42E-07	mg/kg-day	7.30E-01	(mg/kg-day) -1	4.7E-07
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	3.78E-07	mg/kg-day	7.30E+00	(mg/kg-day) -1	2.8E-06
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	6.54E-07	mg/kg-day	7.30E-01	(mg/kg-day) -1	4.8E-07
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	5.89E-07	mg/kg-day	7.30E-02	(mg/kg-day) -1	4.3E-08
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	8.96E-07	mg/kg-day	1.80E+00	(mg/kg-day) -1	1.8E-06
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	4.02E-07	mg/kg-day	1.40E-02	(mg/kg-day) -1	2.2E-08
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	1.50E-04	mg/kg-day	3.50E-01	(mg/kg-day) -1	6.5E-05
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	7.46E-07	mg/kg-day	7.30E-03	(mg/kg-day) -1	5.4E-09
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	5.50E-05	mg/kg-day	1.60E+01	(mg/kg-day) -1	9.8E-04
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	2.68E-09	mg/kg-day	1.80E+00	(mg/kg-day) -1	4.9E-09
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	8.28E-05	mg/kg-day	4.50E+00	(mg/kg-day) -1	4.8E-04
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	1.02E-06	mg/kg-day	9.10E+00	(mg/kg-day) -1	9.3E-06
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	4.88E-08	mg/kg-day	1.60E+00	(mg/kg-day) -1	9.8E-08
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	2.01E-07	mg/kg-day	7.30E-01	(mg/kg-day) -1	1.5E-07
	Naphthalene	6.52E-01	mg/kg	6.52E-01	mg/kg	M	1.11E-06	mg/kg-day	NA	(mg/kg-day) -1	NA
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	1.08E-05	mg/kg-day	1.10E+00	(mg/kg-day) -1	1.2E-05
	(Total)										1.2E-02
										Total Risk Across All Exposure Routes/Pathways	2.2E-02

EPC: Exposure point concentration.
NA: Not available or not applicable.
(1) M: Medium-specific; R: Route-specific.

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TABLE 8.2.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface and Subsurface Soil
Exposure Point:	Onsite
Receptor Population:	Construction Workers
Receptor Age:	Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Oral	2,3,7,8-TCDD	2.33E-02	mg/kg	2.33E-02	mg/kg	M	2.96E-10	mg/kg-day	1.50E+05	(mg/kg-day) -1	4.4E-05
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	1.73E-08	mg/kg-day	1.10E-02	(mg/kg-day) -1	1.9E-10
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	4.71E-07	mg/kg-day	2.40E-01	(mg/kg-day) -1	1.1E-07
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	1.18E-07	mg/kg-day	3.40E-01	(mg/kg-day) -1	4.0E-08
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	4.20E-07	mg/kg-day	3.40E-01	(mg/kg-day) -1	1.4E-07
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	2.81E-08	mg/kg-day	6.38E-02	(mg/kg-day) -1	1.8E-09
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	6.74E-06	mg/kg-day	1.70E+01	(mg/kg-day) -1	1.1E-04
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	9.88E-09	mg/kg-day	6.30E+00	(mg/kg-day) -1	6.2E-08
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	1.85E-08	mg/kg-day	7.30E-01	(mg/kg-day) -1	1.4E-08
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	1.09E-08	mg/kg-day	7.30E+00	(mg/kg-day) -1	7.9E-08
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	1.88E-08	mg/kg-day	7.30E-01	(mg/kg-day) -1	1.4E-08
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	1.69E-08	mg/kg-day	7.30E-02	(mg/kg-day) -1	1.2E-09
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	3.05E-08	mg/kg-day	1.80E+00	(mg/kg-day) -1	5.5E-08
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	7.52E-09	mg/kg-day	1.40E-02	(mg/kg-day) -1	1.1E-10
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	1.40E-05	mg/kg-day	3.50E-01	(mg/kg-day) -1	4.9E-06
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	2.15E-08	mg/kg-day	7.30E-03	(mg/kg-day) -1	1.6E-10
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	2.67E-06	mg/kg-day	1.60E+01	(mg/kg-day) -1	4.3E-05
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	2.51E-10	mg/kg-day	1.80E+00	(mg/kg-day) -1	4.5E-10
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	2.42E-06	mg/kg-day	4.50E+00	(mg/kg-day) -1	1.1E-05
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	3.82E-08	mg/kg-day	9.10E+00	(mg/kg-day) -1	3.5E-07
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	2.43E-09	mg/kg-day	1.60E+00	(mg/kg-day) -1	3.9E-09
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	5.80E-09	mg/kg-day	7.30E-01	(mg/kg-day) -1	4.2E-09
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	4.03E-07	mg/kg-day	1.10E+00	(mg/kg-day) -1	4.4E-07
	(Total)										2.2E-04

Source: Ecology and Environment, Inc., 2000

TABLE 8.2.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Medium:	Soil
Exposure Medium:	Surface and Subsurface Soil
Exposure Point:	Onsite
Receptor Population:	Construction Workers
Receptor Age:	Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	2,3,7,8-TCDD	2.33E-02	mg/kg	2.33E-02	mg/kg	M	1.08E-10	mg/kg-day	1.50E+05	(mg/kg-day) -1	2.2E-05
	2,4,6-Trichlorophenol	1.36E+00	mg/kg	1.36E+00	mg/kg	M	5.28E-08	mg/kg-day	1.10E-02	(mg/kg-day) -1	5.8E-10
	2,4-Dichlorophenol	6.07E-01	mg/kg	6.07E-01	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	4,4'-DDD	3.70E+01	mg/kg	3.70E+01	mg/kg	M	7.66E-08	mg/kg-day	2.40E-01	(mg/kg-day) -1	2.4E-08
	4,4'-DDE	9.30E+00	mg/kg	9.30E+00	mg/kg	M	1.92E-08	mg/kg-day	3.40E-01	(mg/kg-day) -1	8.7E-09
	4,4'-DDT	3.30E+01	mg/kg	3.30E+01	mg/kg	M	6.83E-08	mg/kg-day	3.40E-01	(mg/kg-day) -1	3.1E-08
	4-Chloroaniline	2.21E+00	mg/kg	2.21E+00	mg/kg	M	3.43E-08	mg/kg-day	6.38E-02	(mg/kg-day) -1	2.2E-09
	Aldrin	5.30E+02	mg/kg	5.30E+02	mg/kg	M	6.41E-06	mg/kg-day	1.70E+01	(mg/kg-day) -1	1.5E-04
	alpha-BHC	7.77E-01	mg/kg	7.77E-01	mg/kg	M	1.24E-08	mg/kg-day	6.30E+00	(mg/kg-day) -1	8.1E-08
	Benzo[a]anthracene	1.45E+00	mg/kg	1.45E+00	mg/kg	M	2.93E-08	mg/kg-day	7.30E-01	(mg/kg-day) -1	2.1E-08
	Benzo[a]pyrene	8.56E-01	mg/kg	8.56E-01	mg/kg	M	1.73E-08	mg/kg-day	7.30E+00	(mg/kg-day) -1	1.3E-07
	Benzo[b]fluoranthene	1.48E+00	mg/kg	1.48E+00	mg/kg	M	2.99E-08	mg/kg-day	7.30E-01	(mg/kg-day) -1	2.2E-08
	Benzo[k]fluoranthene	1.33E+00	mg/kg	1.33E+00	mg/kg	M	2.69E-08	mg/kg-day	7.30E-02	(mg/kg-day) -1	2.0E-09
	beta-BHC	2.40E+00	mg/kg	2.40E+00	mg/kg	M	4.09E-08	mg/kg-day	1.80E+00	(mg/kg-day) -1	8.1E-08
	Bis(2-ethylhexyl)phthalate	5.91E-01	mg/kg	5.91E-01	mg/kg	M	1.83E-08	mg/kg-day	1.40E-02	(mg/kg-day) -1	1.0E-09
	Chlordane, technical	1.10E+03	mg/kg	1.10E+03	mg/kg	M	6.83E-06	mg/kg-day	3.50E-01	(mg/kg-day) -1	3.0E-06
	Chrysene	1.69E+00	mg/kg	1.69E+00	mg/kg	M	3.40E-08	mg/kg-day	7.30E-03	(mg/kg-day) -1	2.5E-10
	Di-n-octylphthalate	1.07E+00	mg/kg	1.07E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Dieldrin	2.10E+02	mg/kg	2.10E+02	mg/kg	M	2.51E-06	mg/kg-day	1.60E+01	(mg/kg-day) -1	4.5E-05
	Endrin	5.10E+00	mg/kg	5.10E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	gamma-BHC (Lindane)	1.97E-02	mg/kg	1.97E-02	mg/kg	M	NA	mg/kg-day	1.80E+00	(mg/kg-day) -1	2.2E-10
	Heptachlor	1.90E+02	mg/kg	1.90E+02	mg/kg	M	3.78E-06	mg/kg-day	4.50E+00	(mg/kg-day) -1	2.2E-05
	Heptachlor epoxide	3.00E+00	mg/kg	3.00E+00	mg/kg	M	4.66E-08	mg/kg-day	9.10E+00	(mg/kg-day) -1	4.2E-07
	Hexachlorobenzene	1.91E-01	mg/kg	1.91E-01	mg/kg	M	2.23E-09	mg/kg-day	1.60E+00	(mg/kg-day) -1	4.5E-09
	Indeno[1,2,3-cd]pyrene	4.56E-01	mg/kg	4.56E-01	mg/kg	M	9.20E-09	mg/kg-day	7.30E-01	(mg/kg-day) -1	6.7E-09
	Pyrene	2.68E+00	mg/kg	2.68E+00	mg/kg	M	NA	mg/kg-day	NA	(mg/kg-day) -1	NA
	Toxaphene	3.17E+01	mg/kg	3.17E+01	mg/kg	M	4.92E-07	mg/kg-day	1.10E+00	(mg/kg-day) -1	5.4E-07
	(Total)										2.4E-04
										Total Risk Across All Exposure Routes/Pathways	4.6E-04

EPC: Exposure point concentration.
NA: Not available or not applicable.
(1) M: Medium-specific; R: Route-specific.

Source: Ecology and Environment, Inc., 2000.

3/1/00

AGENCY REVIEW DRAFT

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Receptor Population:	Industrial Workers
Receptor Age:	Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Noncarcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Onsite	2,3,7,8-TCDD	7.6E-03	--	7.4E-03	1.5E-02	2,3,7,8-TCDD	--	--	--	--	--
Soil	Soil	Onsite	2,4,6-Trichlorophenol	2.1E-09	--	1.3E-08	1.5E-08	2,4,6-Trichlorophenol	--	--	--	--	--
Soil	Soil	Onsite	2,4-Dichlorophenol	--	--	--	--	2,4-Dichlorophenol	Nervous system	0.000	--	0.001	0.001
Soil	Soil	Onsite	4,4'-DDD	1.2E-06	--	5.4E-07	1.8E-06	4,4'-DDD	--	--	--	--	--
Soil	Soil	Onsite	4,4'-DDE	4.4E-07	--	1.9E-07	6.3E-07	4,4'-DDE	--	--	--	--	--
Soil	Soil	Onsite	4,4'-DDT	1.6E-06	--	6.8E-07	2.2E-06	4,4'-DDT	Liver	0.0314801	--	0.0136554	0.045
Soil	Soil	Onsite	4-Chloroaniline	2.0E-08	--	4.8E-08	6.8E-08	4-Chloroaniline	Spleen	0.0002636	--	0.0006431	0.001
Soil	Soil	Onsite	Aldrin	1.3E-03	--	3.2E-03	4.4E-03	Aldrin	Liver	8.4265022	--	21.383091	29.810
Soil	Soil	Onsite	alpha-BHC	6.8E-07	--	1.8E-06	2.4E-06	alpha-BHC	--	--	--	--	--
Soil	Soil	Onsite	Benzo[a]anthracene	1.5E-07	--	4.7E-07	6.2E-07	Benzo[a]anthracene	--	--	--	--	--
Soil	Soil	Onsite	Benzo[a]pyrene	8.7E-07	--	2.8E-06	3.6E-06	Benzo[a]pyrene	--	--	--	--	--
Soil	Soil	Onsite	Benzo[b]fluoranthene	1.5E-07	--	4.8E-07	6.3E-07	Benzo[b]fluoranthene	--	--	--	--	--
Soil	Soil	Onsite	Benzo[k]fluoranthene	1.4E-08	--	4.3E-08	5.7E-08	Benzo[k]fluoranthene	--	--	--	--	--
Soil	Soil	Onsite	beta-BHC	6.0E-07	--	1.8E-06	2.4E-06	beta-BHC	--	--	--	--	--
Soil	Soil	Onsite	Bis(2-ethylhexyl)phthalate	1.2E-09	--	2.2E-08	2.4E-08	Bis(2-ethylhexyl)phthalate	Liver	0.000	--	0.000	0.000
Soil	Soil	Onsite	Chlordane, technical	5.4E-05	--	6.5E-05	1.2E-04	Chlordane, technical	Liver	1.049	--	1.280	2.330
Soil	Soil	Onsite	Chrysene	1.7E-09	--	5.4E-09	7.2E-09	Chrysene	--	--	--	--	--
Soil	Soil	Onsite	Di-n-octylphthalate	--	--	--	--	Di-n-octylphthalate	Kidney	0.000	--	0.000	0.001
Soil	Soil	Onsite	Dieldrin	4.7E-04	--	9.8E-04	1.4E-03	Dieldrin	Liver	2.003	--	4.182	6.185
Soil	Soil	Onsite	Endrin	--	--	--	--	Endrin	Liver	0.008	--	0.020	0.028
Soil	Soil	Onsite	gamma-BHC (Lindane)	4.9E-09	--	4.9E-09	9.8E-09	gamma-BHC (Lindane)	Liver	0.000	--	0.000	0.000
Soil	Soil	Onsite	Heptachlor	1.2E-04	--	4.8E-04	6.0E-04	Heptachlor	Liver	0.181	--	0.727	0.908
Soil	Soil	Onsite	Heptachlor epoxide	3.8E-06	--	9.3E-06	1.3E-05	Heptachlor epoxide	Liver	0.110	--	0.269	0.379
Soil	Soil	Onsite	Hexachlorobenzene	4.3E-08	--	9.8E-08	1.4E-07	Hexachlorobenzene	Liver	0.000	--	0.000	0.000
Soil	Soil	Onsite	Indeno[1,2,3-cd]pyrene	4.6E-08	--	1.5E-07	1.9E-07	Indeno[1,2,3-cd]pyrene	--	--	--	--	--
Soil	Soil	Onsite	Naphthalene	--	--	--	--	Naphthalene	Whole body	0.000	--	0.000	0.000
Soil	Soil	Onsite	Pyrene	--	--	--	--	Pyrene	Kidney	0.000	--	0.000	0.000
Soil	Soil	Onsite	Toxaphene	4.9E-06	--	1.2E-05	1.7E-05	Toxaphene	--	--	--	--	--
			(Total)	9.5E-03	--	1.2E-02	2.2E-02	(Total)		11.811	--	27.877	39.687

Total Risk Across Soil: 2.2E-02

Total Risk Across All Media and All Exposure Routes: 2.2E-02

Total Hazard Index Across All Media and All Exposure Routes: 39.687

Total Liver HI = 39.685

Total Kidney HI = 0.001

COPCs: Chemicals of potential concern.

HI: Hazard index.

--: Not applicable or not evaluated.

Source: Ecology and Environment, Inc., 2000

3/1/00

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe:	Current
Receptor Population:	Construction Workers
Receptor Age:	Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Noncarcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Onsite	2,3,7,8-TCDD	4.4E-05	--	2.2E-05	6.6E-05	2,3,7,8-TCDD	--	--	--	--	--
Soil	Soil	Onsite	2,4,6-Trichlorophenol	1.9E-10	--	5.8E-10	7.7E-10	2,4,6-Trichlorophenol	--	--	--	--	--
Soil	Soil	Onsite	2,4-Dichlorophenol	--	--	--	--	2,4-Dichlorophenol	Nervous system	0.000	--	0.001	0.001
Soil	Soil	Onsite	4,4'-DDD	1.1E-07	--	2.4E-08	1.4E-07	4,4'-DDD	--	--	--	--	--
Soil	Soil	Onsite	4,4'-DDE	4.0E-08	--	8.7E-09	4.9E-08	4,4'-DDE	--	--	--	--	--
Soil	Soil	Onsite	4,4'-DDT	1.4E-07	--	3.1E-08	1.7E-07	4,4'-DDT	Liver	0.063	--	0.014	0.077
Soil	Soil	Onsite	4-Chloroaniline	1.8E-09	--	2.2E-09	4.0E-09	4-Chloroaniline	Spleen	0.001	--	0.001	0.001
Soil	Soil	Onsite	Aldrin	1.1E-04	--	1.5E-04	2.6E-04	Aldrin	Liver	16.853	--	21.383	38.236
Soil	Soil	Onsite	alpha-BHC	6.2E-08	--	8.1E-08	1.4E-07	alpha-BHC	--	--	--	--	--
Soil	Soil	Onsite	Benzo[a]anthracene	1.4E-08	--	2.1E-08	3.5E-08	Benzo[a]anthracene	--	--	--	--	--
Soil	Soil	Onsite	Benzo[a]pyrene	7.9E-08	--	1.3E-07	2.1E-07	Benzo[a]pyrene	--	--	--	--	--
Soil	Soil	Onsite	Benzo[b]fluoranthene	1.4E-08	--	2.2E-08	3.6E-08	Benzo[b]fluoranthene	--	--	--	--	--
Soil	Soil	Onsite	Benzo[k]fluoranthene	1.2E-09	--	2.0E-09	3.2E-09	Benzo[k]fluoranthene	--	--	--	--	--
Soil	Soil	Onsite	beta-BHC	5.5E-08	--	8.1E-08	1.4E-07	beta-BHC	--	--	--	--	--
Soil	Soil	Onsite	Bis(2-ethylhexyl)phthalate	1.1E-10	--	1.0E-09	1.1E-09	Bis(2-ethylhexyl)phthalate	Liver	0.000	--	0.000	0.000
Soil	Soil	Onsite	Chlordane, technical	4.9E-06	--	3.0E-06	7.9E-06	Chlordane, technical	Liver	2.099	--	1.280	3.379
Soil	Soil	Onsite	Chrysene	1.6E-10	--	2.5E-10	4.1E-10	Chrysene	--	--	--	--	--
Soil	Soil	Onsite	Di-n-octylphthalate	--	--	--	--	Di-n-octylphthalate	Kidney	0.000	--	0.000	0.001
Soil	Soil	Onsite	Dieldrin	4.3E-05	--	4.5E-05	8.7E-05	Dieldrin	Liver	4.007	--	4.182	8.189
Soil	Soil	Onsite	Endrin	--	--	--	--	Endrin	Liver	0.016	--	0.020	0.036
Soil	Soil	Onsite	gamma-BHC (Lindane)	4.5E-10	--	2.2E-10	6.7E-10	gamma-BHC (Lindane)	Liver	0.000	--	0.000	0.000
Soil	Soil	Onsite	Heptachlor	1.1E-05	--	2.2E-05	3.3E-05	Heptachlor	Liver	0.362	--	0.727	1.089
Soil	Soil	Onsite	Heptachlor epoxide	3.5E-07	--	4.2E-07	7.7E-07	Heptachlor epoxide	Liver	0.220	--	0.269	0.489
Soil	Soil	Onsite	Hexachlorobenzene	3.9E-09	--	4.5E-09	8.3E-09	Hexachlorobenzene	Liver	--	--	--	--
Soil	Soil	Onsite	Indeno[1,2,3-cd]pyrene	4.2E-09	--	6.7E-09	1.1E-08	Indeno[1,2,3-cd]pyrene	--	--	--	--	--
Soil	Soil	Onsite	Pyrene	--	--	--	--	Pyrene	Kidney	0.000	--	0.000	0.000
Soil	Soil	Onsite	Toxaphene	4.4E-07	--	5.4E-07	9.8E-07	Toxaphene	--	--	--	--	--
			(Total)	2.2E-04	--	2.4E-04	4.6E-04			23.621	0.000	27.876	51.497

Total Risk Across Soil: 4.6E-04

Total Risk Across All Media and All Exposure Routes: 4.6E-04

Total Hazard Index Across All Media and All Exposure Routes: 51.497

Total Liver HI = 51.495

Total Kidney HI = 0.001

COPCs: Chemicals of potential concern.
HI: Hazard index.
--: Not applicable or not evaluated.

Source: Ecology and Environment, Inc., 2000.

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TABLE 10.1.RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe: Current
Receptor Population: Industrial Workers
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Noncarcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Onsite	2,3,7,8-TCDD	7.6E-03	--	7.4E-03	1.5E-02						
Soil	Soil	Onsite	4,4'-DDD	1.2E-06	--	5.4E-07	1.8E-06						
Soil	Soil	Onsite	4,4'-DDT	1.6E-06	--	6.8E-07	2.2E-06						
Soil	Soil	Onsite	Aldrin	1.3E-03	--	3.2E-03	4.4E-03	Aldrin	Liver	8.4265022	--	21.383091	29.810
Soil	Soil	Onsite	alpha-BHC	6.8E-07	--	1.8E-06	2.4E-06						
Soil	Soil	Onsite	Benzo[a]pyrene	8.7E-07	--	2.8E-06	3.6E-06						
Soil	Soil	Onsite	beta-BHC	6.0E-07	--	1.8E-06	2.4E-06						
Soil	Soil	Onsite	Chlordane, technical	5.4E-05	--	6.5E-05	1.2E-04	Chlordane, technical	Liver	1.049	--	1.280	2.330
Soil	Soil	Onsite	Dieldrin	4.7E-04	--	9.8E-04	1.4E-03	Dieldrin	Liver	2.003	--	4.182	6.185
Soil	Soil	Onsite	Heptachlor	1.2E-04	--	4.8E-04	6.0E-04	Heptachlor	Liver	0.181	--	0.727	0.908
Soil	Soil	Onsite	Heptachlor epoxide	3.8E-06	--	9.3E-06	1.3E-05	Heptachlor epoxide	Liver	0.110	--	0.269	0.379
Soil	Soil	Onsite	Toxaphene	4.9E-06	--	1.2E-05	1.7E-05						
			(Total)	9.5E-03	--	1.2E-02	2.2E-02	(Total)		11.770	--	27.841	39.611
						Total Risk Across Soil	2.2E-02					Total Hazard Index Across All Media and All Exposure Routes	39.611
						Total Risk Across All Media and All Exposure Routes	2.2E-02						
												Total Liver HI =	39.611

COPCs: Chemicals of potential concern.
HI: Hazard index.
--: Not applicable or not evaluated.

Source: Ecology and Environment, Inc., 2000.

3/1/00

TABLE 10.2.RME
RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE
RIVERDALE CHEMICAL COMPANY SITE

Scenario Timeframe: Current
Receptor Population: Construction Workers
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Noncarcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Onsite	2,3,7,8-TCDD	4.4E-05	--	2.2E-05	6.6E-05						
Soil	Soil	Onsite	Aldrin	1.1E-04	--	1.5E-04	2.6E-04	Aldrin	Liver	16.853	--	21.383	38.236
Soil	Soil	Onsite	Chlordane, technical	4.9E-06	--	3.0E-06	7.9E-06	Chlordane, technical	Liver	2.099	--	1.280	3.379
Soil	Soil	Onsite	Dieldrin	4.3E-05	--	4.5E-05	8.7E-05	Dieldrin	Liver	4.007	--	4.182	8.189
Soil	Soil	Onsite	Heptachlor	1.1E-05	--	2.2E-05	3.3E-05	Heptachlor	Liver	0.362	--	0.727	1.089
Soil	Soil	Onsite	Heptachlor epoxide	3.5E-07	--	4.2E-07	7.7E-07	Heptachlor epoxide	Liver	0.220	--	0.269	0.489
Soil	Soil	Onsite	Toxaphene	4.4E-07	--	5.4E-07	9.8E-07						
			(Total)	2.2E-04	--	2.4E-04	4.6E-04			23.541	0.000	27.841	51.382

Total Risk Across Soil: 4.6E-04

Total Risk Across All Media and All Exposure Routes: 4.6E-04

Total Hazard Index Across All Media and All Exposure Routes: 51.382

Total Liver HI = 51.382

COPCs: Chemicals of potential concern.
HI: Hazard index.
--: Not applicable or not evaluated.

Source: Ecology and Environment, Inc., 2000

D Toxicological Profiles

Aldrin/Dieldrin

Aldrin and dieldrin are man-made chemicals that were used extensively as agricultural pesticides for over 20 years until their use was suspended in 1970. Use of aldrin and dieldrin to control termites continued until 1987, when the manufacturer voluntarily canceled the registration and removed dieldrin from the market.

Although they have not been in use for several years, aldrin and dieldrin persist in the environment and can be found tightly bound to soils and sediment. When aldrin enters the environment, it rapidly changes to dieldrin. Plants can take up dieldrin from soil, and fish or animals that eat dieldrin-contaminated materials can accumulate high concentrations in their body fat.

Aldrin and dieldrin can be absorbed into the body through skin contact, ingestion, and inhalation. The most likely route of human exposure to aldrin/dieldrin is through eating contaminated food. Foods most likely to be contaminated include fish, shellfish, root crops, meat, and dairy products. Exposure to aldrin is limited because aldrin is broken down very quickly to dieldrin in the environment.

Aldrin and dieldrin cause similar health effects. Human poisoning from aldrin and dieldrin is characterized by major voluntary muscle convulsions or kidney damage that can be fatal. Other effects include malaise, incoordination, headache, dizziness, and gastrointestinal disturbances.

Animal studies show effects of aldrin and dieldrin on the nervous system and kidneys similar to the effects in humans. In addition, dieldrin exposure has resulted in increases in liver enzymes and liver weight, decreased immune response, and high mortality in nursing rat pups. Liver damage is the critical or most sensitive effect in animals according to U.S. EPA. It is not known whether humans exposed to aldrin and dieldrin experience similar health effects.

Aldrin and dieldrin are carcinogenic in mice, with the liver being the site of increased tumor incidence. However, there is insufficient evidence to classify dieldrin as a human carcinogen.

U.S. EPA has classified aldrin and dieldrin as group B2, probable human carcinogens.

Chlordane/Heptachlor

Chlordane and heptachlor are man-made pesticides. Chlordane was registered for use in the United States until 1988, when carcinogenicity concerns led to its being banned. Commercial chlordane is a mixture composed primarily of cis-chlordane, trans-chlordane, and heptachlor. Similarly, technical-grade heptachlor contains chlordane. Commercial chlordane is a mixture composed of more than 50 different compounds. It is a white, crystalline, solid possessing a mild, pungent odor. Heptachlor and chlordane were wide-spectrum pesticides used on more than 20 types of crops and in household applications to eliminate termites.

Both chlordane and heptachlor persist in the environment. In the environment, heptachlor is converted to heptachlor epoxide, which is more persistent than the parent compound, by chemical and microbial reactions.

Since chlordane and heptachlor were used on food crops and in homes, there are residual levels in soils, ambient air, and indoor air in many parts of the United States. Groundwater levels of chlordane have been found to range from 0.02 to 830 parts per billion (ppb), while in soil levels up to 57 parts per million (ppm) have been detected.

Chlordane and heptachlor can be absorbed by the body through dermal contact, inhalation of particulates in ambient air, and ingestion of contaminated soils. They may remain stored for months or years in the blood plasma or the body fat of the liver, spleen, brain, and kidneys.

Little data is available on the adverse health effects of chlordane and heptachlor exposure in humans. Symptoms associated with human overexposure to chlordane and heptachlor include headache, dizziness, lack of coordination, irritability, weakness, and convulsions. In humans, an acute oral lethal dose of chlordane was estimated to be between 25 and 50 mg/kg.

Experimental studies exploring the health effects on animals exposed to various levels of chlordane showed an association between exposure and immunologic dysfunction, reproductive dysfunction, nervous system damage, liver damage, convulsions, liver cancer, and death. The lethal dose of chlordane in rats is estimated to be between 85 and 560 mg/kg.

Some occupational epidemiology research supports an increased cancer risk with human exposure to chlordane. Chronic oral treatment with chlordane and heptachlor has resulted in significant increases in hepatocellular carcinomas in mice. U.S. EPA has classified chlordane and heptachlor as Group B2, probable human carcinogens.

DDT/DDE/DDD

DDT is a man-made chemical that has been used extensively throughout the world as a broad-spectrum insecticide. Technical-grade DDT typically contains 80% to 90% 4,4′-DDT as well as other components, including DDD and DDE. Although the agricultural use of DDT in the United States was banned by U.S. EPA in 1972, it is presently widely distributed in the environment as a result of its extensive past use and its high stability and persistence.

Absorption of DDT has been demonstrated following oral, inhalation, and dermal exposure. The primary route of exposure, however, is the oral route.

The major adverse effects of DDT appear to involve the nervous system, the liver, and reproduction and development of offspring. In humans, doses of up to 6 mg DDT/kg usually produce no general illness, but headaches, excessive perspiration, and nausea have been reported. Vomiting, due to nervous system effects rather than gastrointestinal irritation, appears at doses of about 10 mg/kg, and convulsions appear at about 16 mg/kg. Tests in animals suggest that DDT exposure may adversely affect reproduction and long-term exposure may also affect the liver.

Although there is insufficient evidence to classify DDT, DDE, and DDD as carcinogens based on human studies, they have been found to be carcinogenic in a number of animal studies, primarily producing liver tumors. U.S. EPA classifies DDT, DDE, and DDD as Group B2, probable human carcinogens.

Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (PCDDs/PCDFs)

Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDDs/PCDFs) are two classes of related chemicals. There are 75 different forms of PCDD and 135 forms of PCDF. Most studies focus on 2,3,7,8-TCDD, commonly called dioxin, which is the most toxic member of this family of chemicals. For risk assessment purposes, the concentrations of other PCDDs/PCDFs are converted to equivalent concentrations of 2,3,7,8-TCDD using toxicity equivalency factors (TEFs). The PCDDs/PCDFs are then evaluated as if they were the single chemical, 2,3,7,8-TCDD.

Neither PCDDs nor PCDFs are known to occur naturally, nor were they deliberately produced or released to the environment. Rather, they are unwanted trace contaminants formed during the manufacture or burning of certain chlorinated chemicals. Other sources include waste incinerators, copper smelters, steel mills, pulp and paper mills, and automobile exhaust. These compounds tend to absorb to soil and sediments and can persist in the environment for a long time. PCDDs/PCDFs also can accumulate in plant and animal tissues.

Workers in the chemical industry, at municipal and industrial incinerators, and at hazardous waste sites can be exposed to PCDDs/PCDFs. The general public can be exposed to these chemicals by skin contact with contaminated soil and by consuming contaminated fish, meat, milk, or root vegetables. It is unlikely that significant amounts are carried by drinking water or contaminated air; however, an exception is the inhalation of small particles of contaminated fly ash, which could be a major source of exposure for populations near an incinerator.

In humans, overexposure to 2,3,7,8-TCDD has caused chloracne, a severe skin lesion. Chloracne can be very disfiguring and often lasts for years after exposure. There is limited evidence to suggest that 2,3,7,8-TCDD may also cause liver damage, loss of appetite, weight loss, and digestive disorders in humans. EPA has not derived an RfD for 2,3,7,8-TCDD.

Animal studies have shown many different adverse effects of 2,3,7,8-TCDD. The severity and type of adverse effects varies with species. Animal studies have demonstrated severe liver damage, severe weight loss followed by death, toxicity to the immune system, spontaneous abortions, and malformations in offspring whose mothers were exposed to the chemical during pregnancy. In addition, 2,3,7,8-TCDD has been demonstrated to cause cancer in rats and mice and is classified as a Group B2 probable human carcinogen by EPA. The oral and inhalation slope factors presented in HEAST (1.5E+05 [mg/kg-day]-1) are based on liver and respiratory system tumors in rats exposed to 2,3,7,8-TCDD in their diet for 720 days.

EPA has recently issued a Draft Health Assessment document for 2,3,7,8-TCDD and related compounds (EPA 1994z) in which it reviewed all available human population studies, laboratory animal studies, and other experimental data related to their toxic effects. Based on the available information, EPA concluded that TCDD exposure could potentially lead to adverse impacts on human health, such as changes in metabolism or reproductive effects, and that some of these adverse effects may be occurring at concentrations close to ambient background levels.

E

Potential Applicable or Relevant and Appropriate Requirements

APPENDIX E

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Potential ARARs	Removal Action Alternatives			
	Maintain Limestone Cover/Implement Institutional Controls	Install Sitewide Enhanced Asphalt Cap	Localized Hot Spot Removal and Install An Enhanced Asphalt Cap	Excavation and Off-Site Incineration
Action-Specific ARARs				
RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR 262.10-262.89)	Applicable	Applicable	Applicable	Applicable
RCRA Standards Applicable to Transporters of Hazardous Waste (40 CFR 263.10-263.31)	Not Applicable	Not Applicable	Applicable	Applicable
RCRA Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264.1-264.1202)	Not Applicable	Not Applicable	Applicable	Applicable
RCRA Land Disposal Restrictions (40 CFR 269.1-268.5)	Appropriate and Relevant	Appropriate and Relevant	Appropriate and Relevant	Appropriate and Relevant
RCRA Closure and Post-Closure (40 CFR 264.310)	Appropriate and Relevant	Appropriate and Relevant	Appropriate and Relevant	Appropriate and Relevant
Dust Suppression (RCRA § 3004(e)	Applicable	Applicable	Applicable	Applicable
OSHA requirements for workers engaged in response or other hazardous waste operations (29 CFR 1900.120)	Appropriate and Relevant	Appropriate and Relevant	Applicable	Applicable
IAC - Title 35, Part 702, RCRA Permit Program	Applicable	Applicable	Applicable	Applicable
IAC - Title 35, Part 722, Standards Applicable to Generators of Hazardous Waste	Applicable	Applicable	Applicable	Applicable

Key at end of table.

APPENDIX E

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Potential ARARs	Removal Action Alternatives			
	'laintain Limestone Cover/Implement Institutional Controls	Install Sitewide Enhanced Asphalt Cap	Localized Hot Spot Removal and Install An Enhanced Asphalt Cap	Excavation and Off-Site Incineration
Action-Specific ARARs (Cont.)				
IAC - Title 35, Part 728, Land Disposal Restrictions	Applicable	Not Applicable	Applicable	Applicable
IAC - Title 35, Part 729, Prohibited Hazardous Wastes in Land Disposal Units	Not Applicable	Not Applicable	Applicable	Applicable
Chemical-Specific ARARs				
Stormwater Permits (40 CFR 122.26)	Applicable	Applicable	Applicable	Applicable
RCRA Identification and Listing of Hazardous Waste (40 CFR 261.1-261.38)	Applicable	Not Applicable	Applicable	Applicable
National Primary and Secondary Ambient Air Quality Standards (40 CFR 50.6)	Applicable	Applicable	Applicable	Applicable
IAC -Title 35, Part 742, Tiered Approach To Corrective Action Objectives	To Be Considered	To Be Considered	To Be Considered	Applicable
IAC - Title 25, Part 721, Identification and Listing of Hazardous Waste	Not Applicable	Not Applicable	Applicable	Applicable
Location-Specific ARARs				
Publicly Owned Treatment Works Discharge Requirements (Chicago Heights, Illinois)	Not Applicable	Applicable	Applicable	Applicable

Key at end of table.

APPENDIX E

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Potential ARARs	Removal Action Alternatives			
	Maintain Limestone Cover/Implement Institutional Controls	Install Sitewide Enhanced Asphalt Cap	Localized Hot Spot Removal and Install An Enhanced Asphalt Cap	Excavation and Off-Site Incineration
Location-Specific ARARs (Cont.)				
IAC - Title 35, Part 307, Sewer Discharge Criteria	Not Applicable	Applicable	Applicable	Applicable
Noise Emission Standards for Construction Equipment (40 CFR 204)	Applicable	Applicable	Applicable	Applicable

Key:

ARAR = Applicable or relevant and appropriate requirement.
RCRA = Resource Conservation and Recovery Act.
CFR = Code of Federal Regulations.
OSHA = Occupational Safety and Health Administration.
IAC = Illinois Administrative Code.

F

Supplemental Cost Information

BASIS FOR COST ESTIMATES
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

The following general assumptions were used as a basis for the costs estimated for the Riverdale Chemical Company Removal Action.

1. Costs are estimated at 1999/2000 levels.

2. Environmental Cost and Handling Options and Solutions (ECHOS 1999) estimating data are used for much of the estimate line items; ECHOS reference numbers are provided for those items. ECHOS costs include labor, equipment and materials.

3. In addition, R.S. Means, Building Construction Cost Data (BCCD), vendor quotes, and contact reports were also used.

4. For those items which were estimated using vendor quotes, the quoted price was initially reduced by 25%, since overhead and profit was included in the quoted price.. The 25% reduction was added back to the total removal option cost in the overhead and profit line item.

5. This cost estimate includes direct costs, indirect capital costs and O & M costs.

6. Unit weight used for volume calculations of soil is 104 lb/ft^3, or 1.4 tons/cubic yards.

Table 5-1

COMMON COMPONENT COST
ECOLOGICAL SAMPLING
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Reference	Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
(ECHOS)	**Direct Capital Costs**					
33 01 0205	Mobilize crew, 50 miles, per person	2	each	$56.25	1.083	$122
E & E	Biologist	50	hour	$60.00	1.000	$3,000
E & E	Field technician	50	hour	$50.00	1.000	$2,500
state travel rate	Lodging and per diem	8	day	$98.00	1.000	$784
33 02 0401	Disposable materials per sample	17	sample	$7.96	1.083	$147
33 02 0402	Decontamination materials per sample	17	sample	$9.23	1.083	$170
33 02 2023	4-ounce sample jar, case of 24	1	each	$33.45	1.083	$36
33 02 2034	Custody seals, package of ten	2	each	$14.72	1.083	$32
33 02 2043	Overnight delivery 51-70 lb package	5	each	$50.00	1.083	$271
	Analysis for pesticides (QA/QC samples included)	17	sample	$100.00	1.000	$1,700
	Analysis for herbicides (QA/QC samples included)	17	sample	$100.00	1.000	$1,700
	Analysis for dioxin (QA/QC samples included)	17	sample	$760.00	1.000	$12,920
	Subtotal Direct Capital Costs					$23,382
	Overhead and Profit (25%)					$5,846
	Total Direct Capital Costs (Rounded to Nearest $1,000)					$29,000
	Indirect Capital Costs					
E & E	Work plan preparation and reporting					$15,000
	Legal Fees and License/Permit Costs (5%)					$1,450
	Total Indirect Capital Costs (Rounded to Nearest $1,000)					$16,000
	Subtotal Capital Costs					$45,000
	Contingency Allowance (15%)					$6,750
	Total Capital Costs (Rounded to Nearest 1,000)					**$52,000**

Key:

QA/QC = Quality Assurance/Quality Control
lb = pound

Table 5-2

COMMON COMPONENT COST
CONSTRUCT RAW MATERIAL STORAGE AREA
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Reference	Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
(BCCD)	**Direct Capital Costs**					
033 126 0200	Concrete ready mix (base)	417	cubic yard	$61	1.083	$27,526
033 172 4600	Placing concrete (base)	417	cubic yard	$7	1.083	$3,159
032 107 0600	Reinforcing in place, A615 Grade 60 (base)	30.7	ton	$935	1.083	$31,065
031 170 3000	Form work (base)	600	linear feet	$2	1.083	$1,053
033 126 0200	Concrete ready mix (wall)	67	cubic yard	$61	1.083	$4,434
032 107 0700	Reinforcing in place, A615 Grade 60 (wall)	2.5	ton	$835	1.083	$2,234
033 172 5050	Placing concrete (wall)	67	cubic yard	$12	1.083	$843
031 182 0700	Form work (walls)	3612	sfca	$7	1.083	$25,935
022 254 0050	Excavate pipe trench	59	cubic yard	$4	1.083	$264
022 254 3020	Backfill pipe trench	59	cubic yard	$1	1.083	$89
151 451 5100	2" diameter, acid-resistant pipe	200	linear feet	$10	1.083	$2,062
151 975 2180	2" diameter, valve	1	each	$116	1.083	$126
	Subtotal Direct Capital Costs					$98,790
	Overhead and Profit (25%)					$24,698
	Total Direct Capital Costs (Rounded to Nearest $1,000)					$123,000
	Indirect Capital Costs					
	Engineering and Design (7%)					$8,610
	Legal Fees and License/Permit Costs (5%)					$6,150
	Construction Oversight (15%)					$18,450
	Total Indirect Capital Costs (Rounded to Nearest $1,000)					$33,000
	Subtotal Capital Costs					$156,000
	Contingency Allowance (15%)					$23,400
	Total Capital Costs (Rounded to Nearest 1,000)					**$179,000**

Key:
sfca = square foot contact area

Table 6-1

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 2
MAINTAIN LIMESTONE COVER AND INSTITUTIONAL CONTROLS
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Reference	Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
	Direct Capital Costs					
	None					$0
	Indirect Capital Costs					
	None					$0
	Total Capital Costs (Rounded to Nearest $100)					**$0**
	Annual PRSC Costs					
DC01	Cover Maintenance (includes grading)	1,750	cubic yards	$11	1.000	$19,250
DC02	Yearly Summary Report/Cover Inspection	1	lump sum	$4,573	1.083	$4,953
	Subtotal Direct PRSC Costs (Rounded to Nearest $1,000)					$24,000
	Indirect PRSC Costs					
	Overhead and Profit (25%)					$6,000
	Administration (5%)					$1,200
	Insurance, Taxes, Licenses (2.5%)					$600
	Subtotal Indirect PRSC Costs					$7,800
	Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest $1,000)					$32,000
	Contingency Allowance (15%)					$4,800
	Total Annual PRSC Cost (Rounded to the nearest $1,000)					**$37,000**

30-Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	$0
Present Worth of 30 years PRSC (Rounded to Nearest $1,000)	$569,000
Total Alternative Cost (Rounded to Nearest $10,000)	**$570,000**

Key:

PRSC = Post-removal site control

Table 6-2

**REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 3
INSTALL SITEWIDE ENHANCED ASPHALT CAP
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS**

Reference	Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
	Direct Capital Costs					
DC03	Field Overhead and Oversight	1	month	$1,502	1.083	$1,627
DC04	Health and Safety	1	month	$12,887	1.000	$12,887
DC05	Mobilization and Demobilization of Site Equipment	1	lump sum	$3,368	1.083	$3,648
DC06	Air Monitoring	1	month	$4,176	1.083	$4,523
Mat Ser Corp	Add Limestone to establish final Grade (Includes Transportation)	7,000	cubic yard	$10	1.000	$71,925
025 122 0100	Fine Grade (Large Area)	21,000	square yard	$0.49	1.083	$11,144
Gallagher Asphalt	Asphalt Cap	21,000	square yard	$7.04	1.000	$147,840
Wilder Construction	Mattoon Binder	21,000	square yard	$12.80	1.000	$268,800
	Subtotal Direct Capital Costs					$522,394
	Overhead and Profit (25%)					$130,599
	Total Direct Capital Costs (Rounded to Nearest $1,000)					$653,000
	[illegible]					
	Engineering and Design (7%)					$45,710
	Legal Fees and License/Permit Costs (5%)					$32,650
	Construction Oversight (15%)					$97,950
	Total Indirect Capital Costs (Rounded to Nearest $1,000)					$176,000
	Subtotal Capital Costs					$829,000
	Contingency Allowance (15%)					$124,350
	Total Capital Costs (Rounded to Nearest $1,000)					**$953,000**
	Annual PRSC Costs					
025 124 1100	Asphalt Cover Maintenance (2.5% surface area needs yearly maintenance)	525	square yard	$8	1.083	$4,554
Wilder Construction	MatCon Binder	525	square yard	$13	1.000	$6,720
DC02	Yearly Summary Report/Cover Inspection	1	lump sum	$4,573	1.000	$4,573
	Subtotal Direct PRSC Costs (Rounded to Nearest $1,000)					$16,000
	Indirect PRSC Costs					
	Overhead and Profit (25%)					$4,000
	Administration (5%)					$800
	Insurance, Taxes, Licenses (2.5%)					$400
	Subtotal Indirect PRSC Costs					$5,200
	Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest $1,000)					$21,000
	Contingency Allowance (15%)					$3,150
	Total Annual PRSC Cost (Rounded to the nearest $1,000)					**$24,000**

30-Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	$953,000
Present Worth of 30 years PRSC (Rounded to Nearest $1,000)	$369,000
Total Alternative Cost (Rounded to Nearest $10,000)	**$1,320,000**

Key:

PRSC = Post-removal site control.

Table 6-3

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 4
LOCALIZED HOT SPOT REMOVAL AND INSTALL AN ENHANCED ASPHALT CAP
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Reference	Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
	Direct Capital Costs					
DC03	Field Overhead and Oversight	3	month	$1,502	1.083	$4,880
DC04	Health and Safety	2	month	$12,887	1.083	$27,913
DC05	Mobilization and Demobilization of Site Equipment	1	lump sum	$3,368	1.083	$3,648
DC06	Air Monitoring	2	month	$4,176	1.083	$9,045
DC07	Decontamination Pad	1	lump sum	$6,964	1.083	$7,542
020 554 3700	Remove and Replace Rail Spur	200	linear foot	$26.38	1.083	$5,714
022 242 4000	Removal of Limestone Cover	2,041	cubic yard	$0.82	1.083	$1,812
022 242 4040	Excavate Contaminated Soil (Assume direct load into trucks)	5,100	cubic yard	$1.50	1.083	$8,285
Bennett/E & E	Soil Disposal Characterization	35	each	$960	1.000	$33,600
DC08	Transportation and Incineration of Contaminated Soils	5,100	cubic yard	$361	1.000	$1,841,100
DC09	Confirmation Sampling	40	each	$1,177	1.000	$47,080
33 08 0571	40-mil HDPE Liner	2,000	square feet	$1.16	1.083	$2,513
022 212 0200	Borrow (buy and load at pit, haul 2 miles)	5,100	cubic yard	$7.73	1.083	$42,695
022 222 0300	Compaction	7,141	cubic yard	$0.67	1.083	$5,181
Mat Ser Corp	Add Limestone to establish final Grade (Includes Transportation)	7,000	cubic yard	$10	1.000	$68,835
025 122 0100	Fine Grade (Large Area)	21,000	square yard	$0.49	1.083	$11,144
Gallagher Asphalt	Asphalt Cap	21,000	square yard	$7.04	1.000	$147,840
Wilder Construction	MatCon Binder	21,000	square yard	$12.80	1.000	$268,800
	Subtotal Direct Capital Costs					$2,537,627
	Overhead and Profit (25%)					$634,407
	Total Direct Capital Costs (Rounded to Nearest $1,000)					$3,172,000
	Indirect Capital Costs					
	Engineering and Design (7%)					$222,040
	Legal Fees and License/Permit Costs (5%)					$158,600
	Construction Oversight (15%)					$475,800
	Total Indirect Capital Costs (Rounded to Nearest $1,000)					$856,000
	Subtotal Capital Costs					$4,028,000
	Contingency Allowance (15%)					$604,200
	Total Capital Costs (Rounded to Nearest $1,000)					**$4,632,000**
	Annual PRSC Costs					
025 124 1100	Asphalt Cover Maintenance (assumes 2.5% surface area needs yearly maintenance)	525	square yard	$8	1.083	$4,554
Wilder Construction	MatCon Binder	525	square yard	$13	1.000	$6,720
DC02	Yearly Summary Report/Co Inspection	1	lump sum	$4,573	1.000	$4,573
	Subtotal Direct PRSC Costs (Rounded to Nearest $1,000)					$16,000
	Indirect PRSC Costs					
	Overhead and Profit (25%)					$4,000
	Administration (5%)					$800
	Insurance, Taxes, Licenses (2.5%)					$400
	Subtotal Indirect PRSC Costs					$5,200
	Subtotal Direct and Indirect PRSC Costs (Rounded to Nearest $1,000)					$21,000
	Contingency Allowance (15%)					$3,150
	Total Annual PRSC Cost (Rounded to the nearest $1,000)					**$24,000**

30-Year Cost Projection (Assumed discount rate per year: 5%)	
Total Capital Costs	$4,632,000
Present Worth of 30 years PRSC (Rounded to Nearest $1,000)	$369,000
Total Alternative Cost (Rounded to Nearest $10,000)	$5,000,000

Key:

HDPE = High-density polyethylene.

PRSC = Post-removal site control.

Table 6-4

REMOVAL ACTION COST ANALYSIS - ALTERNATIVE 5
EXCAVATION AND OFF-SITE INCINERATION
ENGINEERING EVALUATION/COST ANALYSIS
RIVERDALE CHEMICAL COMPANY
CHICAGO HEIGHTS, ILLINOIS

Reference	Item Description	Quantity	Unit	Cost/Unit	Location Adjustment	Cost
	Direct Capital Costs					
DC03	Field Overhead and Oversight	4	month	$1,502	1.083	$6,507
DC04	Health and Safety	3	month	$12,887	1.083	$41,870
DC05	Mobilization and Demobilization of Site Equipment	1	lump sum	$3,368	1.083	$3,648
DC06	Air Monitoring	3	month	$4,176	1.083	$13,568
DC07	Decontamination Pad	1	lump sum	$6,964	1.083	$7,542
020 554 3700	Remove and Replace Rail Spur	325	linear foot	$26.38	1.083	$9,285
022 242 4000	Removal of Limestone Cover	4,360	cubic yard	$0.82	1.083	$3,872
022 242 4040	Excavate Contaminated Soil (Assume direct load into trucks)	10,900	cubic yard	$1.50	1.083	$17,707
Bennett	Soil Disposal Characterization	28	each	$800	1.000	$22,400
DC08	Transportation and Incineration of Contaminated Soils	10,900	cubic yard	$361	1.000	$3,934,900
DC09	Confirmation Sampling	62	each	$1,177	1.000	$72,974
33 08 0571	40-mil HDPE Liner	3,320	square feet	$1.16	1.083	$4,171
022 212 0200	Borrow (buy and load at pit, haul 2 miles)	10,900	cubic yard	$7.73	1.083	$91,250
022 222 0300	Compaction	10,900	cubic yard	$0.67	1.083	$7,909
025 122 0100	Fine Grade (Large Area)	13,018	square yard	$0.49	1.083	$6,908
	Subtotal Direct Capital Costs					$4,244,511
	Overhead and Profit (25%)					$1,061,128
	Total Direct Capital Costs (Rounded to Nearest $1,000)					$5,306,000
	Indirect Capital Costs					
Assumed	Engineering and Design (3%)					$159,180
Assumed	Legal Fees, Implement Institutional Controls, License/Permit Costs (5%)					$50,000
	Construction Oversight (15%)					$795,900
	Total Indirect Capital Costs (Rounded to Nearest $1,000)					$1,005,000
	Subtotal Capital Costs					$6,311,000
	Contingency Allowance (15%)					$946,650
	Total Alternative Cost (Rounded to Nearest $10,000)					**$7,260,000**

Key:
HDPE = High-density polyethylene.

DERIVED COSTS FOR RIVERDALE REMOVAL ALTERNATIVES

DERIVED COST DC01

LIMESTONE COVER MAINTENANCE

reference	description	quantity	unit	unit cost	cost
Mat Ser Corp	Limestone	1	cubic yard	$4.14	$4
Mat Ser Corp	Transportation & Delivery	1	cubic yard	$6.14	$6
022 222 03000	Compaction	1	cubic yard	$0.67	$1
				DC01	$11

DERIVED COST DC02

COVER INSPECTION

reference	description	quantity	unit	unit cost	cost
E & E	inspection - labor 1 person, 1 day, twice per year	16	hr	$60	$960
assumed	summary report (labor and others)	1	lump sum	$3,500	$3,500
33 01 0205	mobilize crew, 50 mile per person	2	each	$56	$113
				DC02	$4,573

DERIVED COST DC03

FIELD OVERHEAD AND OVERSIGHT

BCCD reference	description	quantity	unit	unit cost	cost/month
015-904-0450	office trailer 50 feet by 10 feet	1	month	$273	$273
010-034-0100	office equipment rental	1	month	$133	$133
010-034-0120	office supplies	1	month	$85	$85
010-034-0140	telephone (2)	1	month	$470	$470
010-034-0160	office lights and hvac	1	month	$88	$88
BFI	garbage disposal	10	cubic yard	$32	$318
016-420-6410	portable chemical toilet	1	month	$135	$135
				DC03	$1,502

Building Construction Cost Data (BCCD), 1999.

DERIVED COST DC04

HEALTH AND SAFETY

reference	description	quantity	unit	unit cost	cost/month
E & E	technician	1	month	$11,000	$11,000
E & E	photo ionization detector (pid)	1	month	$1,012	$1,012
E & E	Mini-ram	1	month	$875	$875
				DC04	$12,887

Note: The above derived cost does not include perimeter air monitoring.
Air monitoring has been costed in DC18.

DERIVED COST DC05

MOBILIZATION AND DEMOBILIZATION OF SITE EQUIPMENT

BCCD reference	description	quantity	unit	unit cost	cost
assumed	mobe/demobe field office	1	each	$500	$500
assumed	clear utilities, coordinate with vendors	40	hour	$50	$2,000
022 274 0020	mobe/demobe, dozer or loader, 105 H.P.	2	each	$182	$363
022 274 0300	mobe/demobe scraper	1	each	$291	$291
022 274 1200	mobe/demobe, tractor shovel or loader	1	each	$214	$214
				DC05	$3,368

DERIVED COST DC06

AIR MONITORING

ECHOS reference	description	quantity	unit	unit cost	cost
33 02 0314	low flow sampling pump	4	month	$180	$720
33 02 0323	manual air sampling kit, detection tubes	4	each	$81	$325
33 02 1826	dioxins, air, (TO-9)	4	each	$323	$1,290
33 02 1810	pesticides/PCBs, GC, air (TO-4)	4	each	$250	$1,000
33 02 2041	overnight delivery, 20 lb package	1	lump sum	$41	$41
E & E	air monitoring reporting	16	hours	$50	$800
				DC06	$4,176

DERIVED COST DC07

DECONTAMINATION PAD

ECHOS reference	description	quantity	unit	unit cost	cost
33 08 0573	80 mil HDPE geomembrane	1,000	square ft	$2.16	$2,160
33 17 0815	1800 psi steam cleaner, 6 HP	1	each	$2,834	$2,834
19 04 0603	sump	1	each	$1,936	$1,936
ASSUMED	carbon treatment of decon water	20	1000 gallon	$0.55	$11
Granite City	discharge of treated liquid to sanitary sewer	27	100 cf	$0.86	$23
				DC07	$6,964

Environmental Cost Handling Options and Solutions (ECHOS), 1999.

DERIVED COST DC08

TRANSPORTATION AND INCINERATION OF CONTAMINATED SOIL

ECHOS reference	description	quantity	unit	unit cost	cost
Bennett Environmental	Transportation	1	cubic yard	$83.43	$83
Bennett Environmental	Incineration	1	cubic yard	$278	$278
Note: assumes a soil density of 1.4 tons per cubic yard				***DC08***	$361

DERIVED COST DC09

CONFIRMATION SOIL SAMPLING

ECHOS reference	description	quantity	unit	unit cost	cost
33 02 0401	disposable materials per sample	1	sample	$7.96	$8
33 02 0402	decontamination materials per sample	1	sample	$9.23	$9
33 02 2023	4-ounce sample jar case of 24	0.1667	each	$33.45	$6
E & E	pesticide analysis	1	each	$125.00	$125
E & E	herbicide analysis	1	each	$125.00	$125
E & E	dioxin analysis	1	each	$900.00	$900
33 02 2034	custody seals package of ten	0.1	each	$14.72	$1
33 02 2043	overnight delivery 51-70 lb package	0.05	each	$66.00	$3
		DC09 (per sample)			$1,177

Assume: Cost is per sample collected. Cost of labor is included in the cost for construction oversight.

CONTACT REPORT

Telephone: (X)

Date: 11/10/99

Client: Thorton Quary Material Service Corporation

Contact: Bob Donahue
Sales Representative

Telephone: 1-312-372-3600

From: Marija Simunic

Summary:

The cost for limestone was needed to estimate a remediation alternative for Riverdale Chemical Company. Bob Donahue, the sales representative, provided a rough cost estimate of $4.80 per ton for limestone + 7.75% tax and $7.12 per ton delivery/transportation for the total job order (purchase, transportation, and delivery of the limestone).

CONTACT REPORT

Telephone: (X)

Date: 11/10/99

Client: Blue Island Pavement Systems

Contact: Eric McNeff
Sales Representative

Telephone: 1-708-396-8893

From: Marija Simunic

Summary:

The cost for spraying sealant over asphalt was needed to estimate a remediation alternative for Riverdale Chemical Company. Eric McNeff, the sales representative, provided a rough cost estimate of $0.50 per square yard for the total job order.

<u>**CONTACT REPORT**</u>

Telephone: (X)

Date: 11/11/99

Client: Gallagher Asphalt Corp.

Contact: John Hite
Sales Representative

Telephone: 1-708-877-7160

From: Marija Simunic

Summary:

The cost for asphalt paving was needed to estimate a remediation alternative for Riverdale Chemical Company. John Hite, the sales representative, provided a rough cost estimate of $17.60 per square yard for the total job order(materials, transportation, labor, delivery).

CONTACT REPORT

Telephone: (X)

Date: 2/22/00

Client: Bennett Environmental Inc.

Contact: Robert Griffiths
Marketing Coordinator

Telephone: 604-681-8828

From: Neil Brown

Summary:

Call to confirm the prices associated with incineration and transportation for soils excavated from the Riverdale Chemical Company site, located in Chicago Heights, Illinois. Mr. Griffiths restated that the cost for soil incineration is $250/ton (U.S.) and estimated cost for transporting the soil from Chicago Heights, Illinois to the Bennett facility would be $75/ton (U.S.).

CONTACT REPORT

Telephone: (X)

Date: 2/22/00

Client: Wilder Construction Co.
Technical Representative

Contact: Carl Yost

Telephone: 429-551-3100

From: Neil Brown

Summary:

Call to confirm the prices associated with the binder agent used to generate the enhanced asphalt. Mr Yost stated that the cost for the binder, which includes support by Wilder, would be approximately $77,400/ acre ($15.99/square yard). This cost assumes an a 4" layer of asphalt would be laid.